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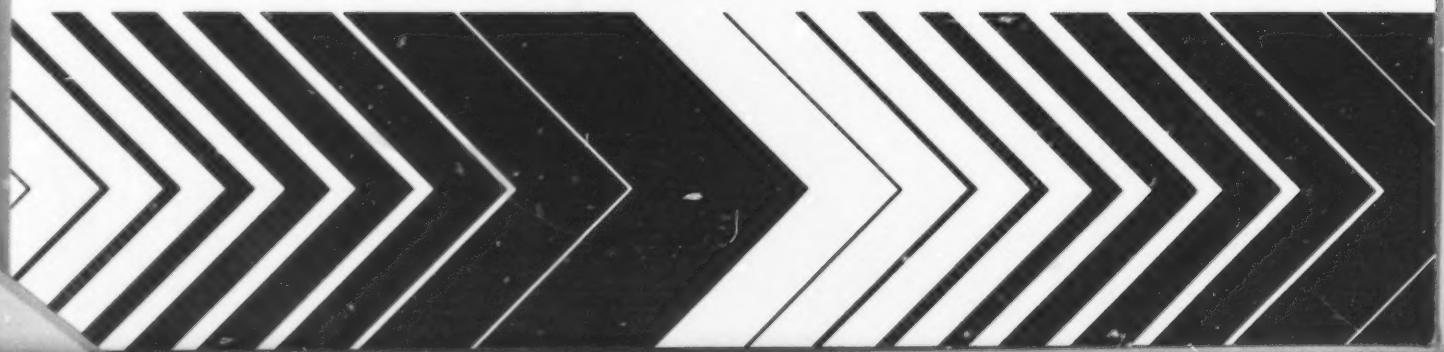

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This report presents the results of the U.S. Environmental Protection Agency's 1984 National Audit Program by pollutant and by analytical method. Semiannual audits were conducted for Pb, NO_3 and SO_4 (filter strips) and one audit was conducted for SO_2 (bubbler), NO_2 (bubbler), CO and high volume flow rate. Continuous SO_2 monitors were audited throughout the year, such that no monitor was audited more than once. Approximately 30 laboratories participated in each semiannual acid rain audit. Twenty laboratories participated in the SO_2 bubbler audit, and 21 in the NO_2 audit, a 20% decrease from 1983. Approximately 55 laboratories participated in each NO_3 and SO_4 audit and approximately 100 laboratories in each Pb audit. Three hundred and thirty CO monitors, 221 SO_2 monitors and 1402 high volume flow samplers were also audited. The results for each 1984 audit are presented in tabular form for each concentration level. The overall performance for all participants for each audit conducted since the beginning of the program is also illustrated in a series of figures.

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AMBIENT AIR AUDITS OF ANALYTICAL PROFICIENCY
-1984-

by

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SECTION 1

INTRODUCTION

The ambient air audits of analytical proficiency are managed by the Environmental Monitoring Systems Laboratory (EMSL), of the U.S. Environmental Protection Agency (EPA). These audits are a part of a continuing program entitled the National Performance Audit Program. This program allows EPA to monitor the performance of laboratories (agencies) making air pollution measurements to assist EPA in assessing the quality of air monitoring data. It also allows participating agencies to assess their performance with respect to other agencies making similar measurements. The audits are conducted by the Quality Assurance Division (QAD) of EMSL. Inquiries and applications to participate should be directed to: U.S. Environmental Protection Agency, Quality Assurance Division, Environmental Monitoring Systems Laboratory, MD-77B, Research Triangle Park, North Carolina 27711.

Agencies participating in the audits are solicited by the EPA Regional Quality Control Coordinator in each of EPA's 10 regions. Agencies performing ambient air monitoring of criteria pollutants are required by Federal regulation to participate. Once a laboratory enrolls in a particular audit, it is automatically notified of subsequent audits of that pollutant. Participants are assigned a permanent identifying code number. Federal, state, local, industrial and foreign air pollution monitoring agencies participate in the surveys.

Sample materials furnished for the audits are designed to simulate the several types of collected air pollution samples as closely as possible. The materials for the manual methods evaluate only the analytical portion of the total air measurement process; i.e., they do not determine errors in sample collection, transportation, handling, storage, and data processing. For the high volume method for total suspended particulate (TSP), the audit evaluates only the flow measurement portion of the method.

In 1984, audits were conducted twice for lead, sulfate, nitrate and acid rain and once for carbon monoxide, high-volume flow rate, manual sulfur dioxide and manual nitrogen dioxide. Audits on SO_2 continuous monitors were conducted throughout the year.

Each laboratory participating in an audit received an evaluation of its performance shortly after the audit was completed. When practical, laboratories submitting abnormally high or low results were offered an opportunity to analyze another set of samples. However, the retest results are not included in this summary report.

There are approximately 667 laboratories registered in the National Performance Audit Program. This report presents the results of those laboratories that participated in the 1984 audits. The category and number of participants in each audit are presented in Table 1. Compared to the 1983 audits (1) the number of participants in the SO_2 and NO_2 bubbler audits decreased by 20% and the number in the CO audit decreased 50% (only one audit was done in 1984 versus two in 1983). Participation in the other audits, however, increased as follows: $SO_4^=$, 7%; NO_3^-, 5%; Pb, 4%; high volume flow rate, 4%, and SO_2 continuous, 18%.

Throughout this report, reference is made to "assigned values." These values are the standards against which reported results are evaluated and have been so designated after consideration of the analytical results of the referee laboratory, the QAD/EMSL Standards Laboratory, and the manufacturer of the audit material.

SECTION 2

SUMMARY AND CONCLUSIONS

The 1984 results closely parallel those of last year. The overall average accuracy for all 1984 audits is 95 percent, the same as for the 1983 and 1982 audits (1, 2). With outliers removed and the values for all levels averaged, the percentage of results within 20 percent of the assigned values ranged from a low of 92% (nitrate) to a high of 100% (NO_2).

The following percentage of results were rejected as outliers for each type of audit: SO_2 bubbler (0%), NO_2 bubbler (0%), CO (1.8%), $SO_4^=$ (3.7%), NO_3^- (7.7%), Pb (4.47%), flow rate (6.6%), SO_2 continuous (0%) and acid rain (0%).

SECTION 3

AUDIT MATERIALS

The audit samples span the wide range of pollutant concentrations experienced in ambient air monitoring. This is achieved directly with the CO samples, which are prepared in cylinders. Dilution is necessary for the acid rain samples, lyophilized SO_2 and aqueous NO_2 samples in order to obtain desired concentrations. Lead, NO_3^-, and $SO_4^=$ filter strip samples require both dissolution and dilution to arrive at the needed range of concentrations. The SO_2 continuous monitor audit samples require dilution of the SO_2 with zero air.

Although many air monitoring sites rarely encounter pollutant concentrations at the higher audit sample levels, these concentrations are included to assure that monitoring methods are verified at the higher levels.

The following paragraphs describe each sample type used in the 1984 audits.

SULFUR DIOXIDE (MANUAL)

Lyophilized samples, composed of sodium sulfite and potassium tetrachloromercurate, simulate ambient air samples collected according to the Pararosaniline Method, the reference method for determining SO_2 in the atmosphere. In the 1984 audits, the concentrations ranged from approximately 65 to 220 µg of sulfur dioxide equivalent per cubic meter when reconstituted properly. A sample set consisted of five different concentrations.

NITROGEN DIOXIDE (MANUAL)

Nitrogen dioxide samples consist of aqueous sodium nitrite solutions that simulate ambient NO_2 samples collected by a 24-hour NO_2 bubbler method. Audit results are expressed in terms of micrograms per milliliter (nitrite concentration). These solutions, when properly diluted according to directions, are equivalent to collected atmospheric NO_2 concentrations of approximately 0.4 to 1.2 µg/mℓ. A sample set consists of five different concentrations.

CARBON MONOXIDE

These audit materials consist of a mixture of CO, CO_2 and CH_4 and zero air in a pressurized gas cylinder that simulates an ambient air sample. The concentrations of the three CO samples used in the 1984 audits ranged from

4 to 41 ppm. Directions specify that the gas sample be introduced into a continuous analyzer in the "sample" mode, which permits the analyzer to draw the sample in the same fashion and at the same flow rate as during ambient air monitoring.

SULFATE, NITRATE, AND LEAD ON FILTER STRIPS

The filter strip samples used in sulfate, nitrate and lead audits are each 1.9 cm wide by 20 cm long. They are cut from 20- by 24-centimeter glass fiber filters that have been spiked with an aqueous solution of the appropriate solution and then oven dried. After analysis, pollutant concentrations are computed by assuming that the samples were collected on the prescribed high-volume filter with a sample air volume of 2,000 m^3. Six sample strips comprise a set.

Sulfate and nitrate audit samples are prepared from sodium sulfate and potassium nitrate. Calculated nitrate concentrations ranged from 0.85 to 14.0 $\mu g/m^3$ and sulfate from 1.7 to 26.0 $\mu g/m^3$. Lead samples, which are prepared from lead nitrate ranged in concentration from 0.61 to 7.4 $\mu g/m^3$ of lead.

HIGH-VOLUME FLOW RATE (ReF DEVICE)

The reference flow (ReF) device used for audits of high-volume flow rates consist of a modified orifice, a wind deflector, a manometer, and a series of resistance plates that simulate particulate loading. A single ReF device is supplied to each participating agency with instructions to check samplers at as many sampling sites as feasible within the allotted time.

Each ReF device is calibrated with a positive displacement meter before use. During use, the device is mounted on top of the sampler, replacing the filter face plate. A wind deflector is used to prevent fluctuations in the measurements due to wind blowing across the orifice.

SULFUR DIOXIDE CONTINUOUS MONITORS

The continuous monitor auditing system is an auditing device for SO_2 continuous ambient air monitors. The device is a porous plug dilution system that provides a mechanism whereby controlled quantities of SO_2 and diluent air are continuously combined in a mixing chamber and passed into the monitor. The flow rate of each gas is controlled by maintaining a predetermined pressure drop across the porous plus flow restrictor. Variable SO_2 concentrations are obtained by switching between four restrictors.

The audit device, which is housed in a compact, lightweight, impact-resistant case, is constructed so that only those controls required for system operation are exposed. By opening and closing different toggle valves, it is possible to generate up to seven preset pollutant concentrations. Five are used for the audit. Two compressed gas cylinders are supplied with each unit, one as the pollutant source and the other for dilution.

Each audit device is calibrated for flow at all the settings used in the audit. Flow calibrations are referenced to laminar flow elements traceable to National Bureau of Standards flow standards. Sulfur dioxide concentrations ranging from 0.00 to 0.702 ppm were used in the 1984 audit.

ACID RAIN

Approximately 34 laboratories participated in each 1984 audit. Five samples in polyethylene bottles were shipped to each of the participating laboratories. Three samples were analyzed for pH, conductivity, acidity and the major cations and anions normally measured in precipitation samples. The other two samples were analyzed for heavy metals. The latter two samples were acid stabilized to prevent loss of metals from the solution.

The chemical composition of these samples was certified by the U.S. National Bureau of Standards. The participants analyzed the samples using the analytical procedures they normally employ when analyzing their precipitation samples. The results were reported based on the sample concentration after dilution (1:50).

SECTION 4

AUDIT RESULTS

The results of the 1984 audit are presented in Tables 2 through 31. The term "audit mean" in these tables denotes the average of all values reported by the participants for that sample after elimination of outliers. Elimination of outliers was accomplished in a two step procedure. First, results from laboratories/sites reporting values exceeding ± 20 percent of the assigned value for all samples in a particular audit were removed from the data base. These excluded values represented 4.8 percent of the total number of laboratories/sites reporting results (approximately the same as in 1982 and 1983). Then, individual results were rejected as outliers based on Chauvenet's Criterion (4). After eliminating outliers, the results from all participants were normally distributed.

At each audit level, the percent accuracy (% Acc.) and the precision, as measured by the percent coefficient of variation (%CV), were computed as follows:

$$\% \text{ Acc.} = \frac{\text{audit mean} - \text{EPA assigned value}}{\text{EPA assigned value}} \times 100$$

$$\% \text{ CV} = \frac{\text{audit standard deviation}}{\text{audit mean}} \times 100$$

The percent accuracy measures how well the average of all participants agrees with EPA's assigned values. The percent coefficient of variation measures the variability among participants. The accuracy results for the acid rain audit were also calculated in terms of the median because of the low participation level.

Overall accuracy and precision values for each audit were also calculated and plotted (Figures 1 through 25) to show the historical record of performance for each type of audit. Many readers may find that scanning these figures provides a better understanding of the 1984 results compared to scanning the tabulated results and reading the text of this report.

SULFUR DIOXIDE (BUBBLER)

Twenty laboratories participated in the audit - 20 percent less than in 1983. Participation has steadily decreased since 1981 (3) due to the increasing number of laboratories changing to automated analyzers. Because of the low level of participation, this audit will be discontinued after 1985.

The audit mean, percent accuracy and percent CV, with and without outliers, are reported in Table 2. As usual the lowest precision and accuracy was achieved in level one. Overall, however, the average percent accuracy appears to have stabilized over the past four audits when compared to audits of previous years (Figure 1). Precision, which improved in 1982 and 1983 continued to improve (Figure 1).

As shown in Table 3, accuracy for the manual pararosaniline method, ranged from -11.6 to 6.6% for all data and -3.8 to 5.0% after outliers are removed. Accuracy for the automated method ranged from -0.44 to 21.3% for all data and 0.44 to 9.6% after outliers were removed. Concentration did not appear to affect the precision for either methods.

Table 4, constructed with the outliers removed, shows the percentage of laboratories that obtained results within ± 10, 20, 30 and 50 percent of the assigned values. Better than 90 percent of the measurements fell within 20 percent of the assigned values, a greater percentage than 1983 (87%) and 1982 (88%).

NITROGEN DIOXIDE

Twenty-one laboratories participated in the 1984 audit -- 20% less than in 1983 and 50% less than in 1982. The decrease, which occurred among the state and local participants, likely resulted because an increasing number of laboratories are replacing bubblers with continuous analyzers. Because of the low level of participation, this audit will be discontinued after 1985.

The audit mean, percent accuracy and percent CV with and without outliers are reported in Tables 5 and 6. The accuracy was about the same as for 1983 audits (Figure 2). This figure also shows that with a few exceptions the precision and accuracy over the years has been good. In fact, in 1984, all values were within 10% of the assigned value.

CARBON MONOXIDE

In 1984, 330 monitors were audited -- a 50% decrease from 1983. This decrease occurred because for budgetary reasons only one audit was done in 1984 versus two in 1983. Ninety-five percent of the monitors audited were NDIR — about the same as 1983. Although other types of CO monitors were also audited, the number were too few to make meaningful comparisons with the 1983 audit results.

As shown in Figure 3, both precision and accuracy have reached a plateau in the last five years. For example, the number of measurements falling within 20% of the assigned value (Table 10) closely parallels the 1983 and 1982 results. Also, as shown in Figure 3, the accuracy has oscillated back and forth across the x-axis for the last four years.

SULFATE ON FILTER STRIPS

Approximately 55 laboratories participated in each audit -- about 7 percent fewer than in 1983. The audit mean, percent accuracy and precision are given in Table 11. Over the years accuracy has varied quite a bit, but it now seems to have stabilized (Figure 4). Precision, on the other hand, has continued to improve slightly. In 1983, the precision and accuracy of the manual method increased with concentration, but this year, no such relationship is apparent (Table 12). As in 1983, there also is no apparent relationship between concentration and either precision or accuracy for the automated method (Table 13).

Except for the lowest sample concentration, between 70 and 96 percent of the laboratories reported results within ± 20 percent of the assigned values (Table 14). These results are worse than for 1983 where the values were 84 and 97 percent, respectively.

NITRATE ON FILTER STRIPS

Approximately 46 laboratories participated in each 1984 audit. Participation was down approximately 2 percent from 1983 but, as in the sulfate audits, the number of participants has been fairly constant since 1979. Accuracy continues to vary widely from audit to audit, but precision seems to have reached a plateau (Figure 5).

The results from the 1984 nitrate audits show a slight decrease in both precision and accuracy with respect to the 1983 audits (Figure 5, Table 15). This decrease is also evident in the automated methods (Table 16) which reverses the general improvement that was observed in 1982 and 1983.

Some other methods used by a few of the participants included the manual cadmium reduction, brucine, hydrazine, 2,4 xylenol, selective ion electrode, and the szechrome NAS methods. The number of results reported was too small to calculate precision and accuracy.

The percentage of values that fell within ± 20 percent of the assigned values was considerably lower (84%) than in 1983 (90%) and 1982 (90%).

LEAD ON FILTER STRIPS

One hundred and four laboratories participated in the 0184 audit and 102 in the 0784, a 3 percent increase over the 1983 audits. The increase was due to more participation from federal and foreign agencies. Participation has leveled off in the past three years and has ranged from 95 to 105 laboratories per audit.

The audit mean, percent accuracy and percent CV (precision) are shown in Table 18. Accuracy has contiuued to show the negative bias present since the audits were initiated in 1977 and precision has remained at the same level since 1982 (Figure 6). (There is no explanation for the negative bias at this time.) In 1984 the number of measurements within ± 20

percent of the assigned value (79%) was slightly lower (Table 19) than in the 1983 audits. With the exception of two laboratories using the inductively coupled argon plama optical emission spectrometric method, all others used the atomic absorption method.

SULFUR DIOXIDE (CONTINUOUS MONITORS)

The number of monitors audited totaled 221 (Table 20). Compared to 1983, this was an increase of 18 percent and resulted mainly because of increased participation among local agencies.

The accuracy for each of the methods is shown in Table 21. The methods most commonly used were: fluorescence (204), flame photometric (8) and coulometric (5). In relation to 1983, these numbers represent a 30% increase, 300% decrease and 15% decrease, respectively. Whether the large decrease in the number of flame photometric analyzers and the large increase in the number of fluorescent analyzers represents a shift in user preference is not known at this time. With one exception the accuracy of the fluorescent and the coulometric methods showed improvement over the 1983 results.

HIGH VOLUME

The number of monitors audited in 1984 was 1402 which represented a 4% increase over 1983. The pressure transducer continued to be the most widely used method of measurement (49.4%), the rotameter was next (27.5%), followed by pressure transducer/flow controller (5.5%). Other methods which accounted for the remaining 17.6 percent of the results, included: orifice manometer, manometer, flow gauge, and pressure transducer/non-continuous. The results (Table 22) showed an overall decrease in accuracy compared to 1983. For example, in 1983 20% of the results were within 1.1% of the assigned value (all methods) but in 1984 only 20% were within 1.3%. The corresponding values at 40% were 2.3 and 2.7.

Table 23 shows the percentage of the flow measurements within ± 20% of the true value for each resistance plate used in the ReF (audit) device. These results are similar to the CY-83 results.

ACID RAIN

Thirty-seven laboratories participated in the 0484 audit and thirty-three participated in the 1184 audit. Overall this represents a 17% increase in participation compared to 1983. Because of the short history of this audit (1983 was only the second year), it is possible at this time to make only general observations about the results. In the tables that follow, the accuracy is expressed in terms of the mean value. However, the low participation level in each audit means that only a few analyses are reported for certain of the analytes. In such situations the median value may give a better estimate of the accuracy. For this reason the percent accuracy is presented in Figures 7 to 25 in terms of the median (solid line) and the mean (dashed line).

Also, because of the low concentrations present in some of the samplers, the relative precision sometimes appears as poor, when, in absolute terms (e.g., mg/l) the precision is reasonably good.

Results for pH, Conductivity and Acidity

The results are presented in Table 24 (all data), Table 25 (outliers removed) and in Figures 7 (pH), 8 (conductivity) and 9 (acidity). Inspection of the data in the tables does not reveal any correlation between sample concentration and either precision or accuracy. This is very different from the ambient air audits reported earlier in this report, i.e., for these latter audits precision and accuracy generally correlate with the concentration. For both pH and acidity, the median and the mean value give approximately the same overall accuracy result (Figures 7 and 9, respectively). However, in the calculation of the overall accuracy for conductivity, the results from using the mean value differs considerably from that obtained using the median value. Precision on the other hand has been relatively constant for pH and conductivity (Figures 7 and 8, respectively) but it has been erratic for acidity.

Major Anions Results (SO_4, NO_3, Cl, F)

The results for these four parameters are presented in Table 26 (all data), Table 27 (outliers removed) and in Figures 10 (SO_4), 11 (NO_3), 12 (Cl) and 13 (F). Inspection of these figures shows that the % accuracy value calculated from the median value generally agrees with that calculated for the mean value. Precision has exceeded 10 percent in all audits and has also been erratic. As shown by comparing the precision in Tables 26 and 27, however, removal of only a few results yields a larger improvement in precision. Thus, the results are not as poor as they appear on the surface.

Major Cations (NH_4, Ca, K, Mg, Na)

The results for these five major ions are presented in Table 28 (all data), Table 29 (outliers removed) and in Figures 14 (NH_4), 15 (Ca), 16 (K), 17 (Mg) and 18 (Na). Inspection of these figures shows that for three of the ions (NH_4, Ca, K) the % accuracy value calculated from the median value agrees with that calculated from the mean value. This is not the case, however, for the other two ions (Mg, Na). As in the case for the major anions, the precision has been erratic for all five anions over the history of the audit. But, also as in the anion case, removing just one or two values yields a dramatic improvement in precision. Thus, the results are not as poor as they appear.

Trace Metals Results (Mn, Fe, Cd, Cu, Ni, Pb, Zn)

The results for these seven metals are presented in Table 30 (all data), Table 31 (outliers removed) and in Figures 19 (Mn), 20 (Fe), 21 (Cd), 22 (Cu), 23 (Ni), 24 (Pb), and 25 (Zn). As in the case for the cations, for some metals the % accuracy as calculated from the median value agrees well with that calculated from the mean value (Mn, Cd, Cu and Zn), but this is not the case for the other metals (Fe, Ni, and Pb). Also as in the case

of both the anions and cations, the precision has varied in an erratic manner for most of these metals (Zn is the exception). It should be borne in mind, however, that the small concentrations used for these metals does mean that a small absolute difference appears as a large relative difference.

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TABLE 1. AGENCY PARTICIPATION

Survey	Distribution (%)					No. of Laboratories[a]	No. of Monitors[a]
	States	Local	Industry	Federal	Foreign		
SO_2 -- June 1984	20.0	45.0	30.0	5.0	0.0	20 (0)	--
NO_2 -- June 1984	38.1	42.9	19.0	0.0	0.0	21 (0)	--
CO -- April 1984	43.8	43.6	7.3	0.1	5.2	--	330 (6)
SO_4 -- February 1984	47.3	20.0	21.8	1.8	9.1	55 (2)	--
SO_4 -- August 1984	41.7	18.9	24.7	3.4	11.3	53 (2)	--
NO_3 -- February 1984	44.4	15.6	28.9	0.0	11.1	45 (2)	--
NO_3 -- August 1984	45.6	15.2	23.9	2.2	13.1	46 (7)	--
Pb -- January 1984	40.8	24.2	26.4	4.3	4.3	104 (5)	--
Pb -- July 1984	41.1	27.4	23.5	3.9	3.9	102 (4)	--
SO_2 (continuous)	56.1	39.8	2.3	0.9	0.9	--	221 (0)
High-Volume Flow-Rate -- May 1984	37.7	7.2	13.2	0.4	1.5	--	1402 (92)
Acid Rain -- April 1984	43.2	8.1	27.0	21.6	0.0	37	--
Acid Rain -- October 1984	42.4	12.1	30.3	15.2	0.0	33	--

[a]Value in parentheses is the number of laboratories/monitors that reported all values off by more than ± 20% from the true value.

TABLE 2. AUDIT RESULTS FOR MANUAL SULFUR DIOXIDE METHOD (BUBBLER)

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0684	1	20	67.70	71.16	5.11	30.35
	2	20	91.60	90.88	-0.79	7.47
	3	20	122.60	113.20	-7.67	22.19
	4	19	145.20	152.57	5.00	6.50
	5	20	218.20	226.33	3.73	33.37
			B. OUTLIERS REMOVED			
0684	1	19	67.70	66.51	-1.76	9.08
	2	20	91.60	90.88	-0.79	7.47
	3	19	122.60	118.55	-3.30	6.60
	4	18	145.20	151.23	4.15	5.46
	5	18	218.20	223.48	2.42	5.09

TABLE 3. RESULTS FOR THE PARAROSANILINE METHOD

Audit	Level	Assigned value ($\mu g/m^3$)	Manual Method (01) n	Manual Method (01) Mean ($\mu g/m^3$)	Manual Method (01) % Acc.	Manual Method (01) % CV	Automated Method (02) n	Automated Method (02) Mean ($\mu g/m^3$)	Automated Method (02) % Acc.	Automated Method (02) % CV
					A. ALL DATA					
0684	1	67.70	13	72.19	6.63	36.72	7	69.25	3.29	11.65
	2	91.60	13	88.06	-3.86	6.06	7	96.12	4.83	6.56
	3	122.60	13	108.42	-11.57	27.83	7	122.06	-0.44	4.90
	4	145.20	12	148.72	2.42	4.91	7	159.17	9.62	6.79
	5	218.20	13	205.66	-5.75	27.20	7	264.71	21.32	36.16
					B. OUTLIERS REMOVED					
0684	1	67.70	12	64.92	-4.11	6.28	7	69.28	2.33	11.65
	2	91.60	13	88.06	-3.86	6.06	7	96.12	4.93	6.56
	3	122.60	12	116.50	4.98	7.07	7	122.06	-0.44	4.90
	4	145.20	11	147.16	1.35	3.50	7	159.17	9.62	6.79
	5	218.20	12	220.87	1.22	5.23	6	228.69	4.81	4.31

TABLE 4. PERCENT OF SULFUR DIOXIDE MEASUREMENTS WITHIN INDICATED PERCENT OF ASSIGNED VALUES (ALL DATA)[a]

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
0684	1	67.70	70.0	95.0	95.0	95.0
	2	91.60	80.0	100.0	100.0	100.0
	3	122.60	90.0	90.0	95.0	95.0
	4	145.20	75.0	90.0	95.0	95.0
	5	218.20	75.0	90.0	90.0	90.0

[a]Percentage difference table unchanged after outliers deleted.

TABLE 5. AUDIT RESULTS FOR NITROGEN DIOXIDE MANUAL METHOD (BUBBLER)

Audit	Level	n	Assigned value (μg/ml)	Mean (μg/ml)	% Acc.	% CV
			A. ALL DATA			
0684	1	21	0.363	0.355	-2.20	4.23
	2	21	0.636	0.602	-5.35	2.82
	3	21	0.750	0.748	-0.27	2.27
	4	21	0.960	0.956	-0.42	3.35
	5	21	1.205	1.147	-4.81	2.44
			B. OUTLIERS REMOVED			
0684	1	19	0.363	0.352	-3.03	2.56
	2	20	0.636	0.600	-5.66	2.27
	3	20	0.750	0.750	0.00	2.00
	4	21	0.960	0.956	-0.42	3.35
	5	21	1.205	1.147	-4.81	2.44

TABLE 6. AUDIT RESULTS FOR NITROGEN DIOXIDE BY THE SODIUM ARSENITE METHOD

Audit	Level	Assigned value (µg/mL)	Manual Method (05) n	Mean (µg/mL)	% Acc.	% CV	Automated Method (06) n	Mean (µg/mL)	% Acc.	% CV
				A. ALL DATA						
0684	1	0.363	14	0.356	-1.93	4.78	7	0.354	-2.48	2.26
	2	0.636	14	0.600	-5.66	3.17	7	0.607	-4.56	2.47
	3	0.750	14	0.751	0.13	2.13	7	0.740	-1.33	2.57
	4	0.960	14	0.954	-0.63	3.77	7	0.959	-0.10	2.50
	5	1.205	14	1.146	-4.90	2.53	7	1.150	-4.56	2.35
				B. OUTLIERS REMOVED						
0684	1	0.363	14	0.356	-1.93	4.78	7	0.354	-2.40	2.25
	2	0.636	13	0.596	-6.29	2.18	7	0.607	-4.56	2.47
	3	0.750	17	0.751	0.13	2.13	7	0.740	-1.33	2.57
	4	0.960	14	0.954	-0.63	3.77	7	0.959	-0.10	2.50
	5	1.205	14	1.146	-4.90	2.53	7	1.150	-4.56	2.25

TABLE 7. PERCENTAGE OF NITROGEN DIOXIDE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE (ALL DATA)[a]

Audit	Level	Assigned value (µg/mL)	10%	20%	30%	50%
0684	1	0.36	100.0	100.0	100.0	100.0
	2	0.64	100.0	100.0	100.0	100.0
	3	0.75	100.0	100.0	100.0	100.0
	4	0.96	100.0	100.0	100.0	100.0
	5	1.21	100.0	100.0	100.0	100.0

[a]Percentage distribution table unchanged after outliers removed.

TABLE 8. AUDIT RESULTS FOR CARBON MONOXIDE

Audit	Level	n	Assigned value (ppm)	Mean (ppm)	% Acc.	% CV
			A. ALL DATA			
0484	1	333	4.33	4.33	0.00	50.12
	2	334	17.59	17.62	0.17	10.56
	3	332	40.50	40.51	0.02	5.87
			B. OUTLIERS REMOVED			
0484	1	324	4.33	4.18	-3.46	10.53
	2	322	17.59	17.69	0.57	3.45
	3	321	40.50	40.79	0.72	2.60

TABLE 9. AUDIT RESULTS FOR CARBON MONOXIDE BY THE NDIR METHOD

Audit	Level	Assigned value (ppm)	NDIR n	NDIR Mean (ppm)	NDIR % Acc.	NDIR % CV
			A. ALL DATA			
0484	1	4.33	308	4.34	0.23	51.84
	2	17.59	309	17.64	0.28	10.77
	3	40.50	307	40.51	0.02	5.75
			B. OUTLIERS REMOVED			
0484	1	4.33	301	4.19	-3.23	10.50
	2	17.59	299	17.71	0.68	3.39
	3	40.50	298	40.79	0.72	2.60

TABLE 10. PERCENTAGE OF CARBON MONOXIDE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value (ppm)	10%	20%	30%	50%
		A. ALL DATA				
0484	1	4.33	77.6	96.7	98.5	99.4
	2	17.59	96.7	98.8	99.4	100.0
	3	40.50	99.4	98.5	98.8	100.0
		B. OUTLIERS REMOVED				
0484	1	4.33	78.0	95.4	98.8	99.4
	2	17.59	98.5	99.4	99.7	100.0
	3	40.50	99.4	99.4	99.4	100.0

TABLE 11. AUDIT RESULTS FOR SULFATE ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0284	1	52	1.72	2.20	27.91	62.72
	2	54	3.24	3.50	8.02	32.29
	3	55	7.75	8.03	3.61	39.48
	4	55	11.34	11.08	-2.29	19.68
	5	55	18.73	18.16	-3.04	11.67
	6	55	25.59	24.59	-3.91	13.58
0884	1	51	1.98	2.40	21.21	33.75
	2	51	3.54	3.76	6.21	34.84
	3	53	11.58	12.74	10.02	33.99
	4	53	25.88	26.30	1.62	35.36
	5	53	18.64	19.40	4.08	35.57
	6	51	5.04	5.93	17.66	40.98
			B. OUTLIERS REMOVED			
0284	1	48	1.72	1.96	13.96	33.16
	2	49	3.24	3.31	2.16	16.31
	3	51	7.75	7.78	0.39	9.77
	4	52	11.34	11.18	-1.41	9.84
	5	51	18.73	18.39	-1.82	7.40
	6	52	25.59	24.50	-4.26	10.24
0884	1	46	1.98	2.18	10.10	19.27
	2	47	3.54	3.54	0.00	13.28
	3	51	11.58	11.95	3.20	6.03
	4	50	25.88	25.44	-1.70	5.90
	5	50	18.64	18.83	1.02	6.11
	6	48	5.04	5.37	6.55	12.66

TABLE 12. AUDIT RESULTS FOR SULFATE BY THE MANUAL METHODS

Audit	Level	Assigned value ($\mu g/m^3$)	$BaCl_2$ (17) n	$BaCl_2$ (17) Mean ($\mu g/m^3$)	$BaCl_2$ (17) % Acc.	$BaCl_2$ (17) % CV	Sulfa-Ver (19) n	Sulfa-Ver (19) Mean ($\mu g/m^3$)	Sulfa-Ver (19) % Acc.	Sulfa-Ver (19) % CV
				A. ALL DATA						
0284	1	1.72	8	2.39	38.95	41.84	2	1.50	-12.79	130.00
	2	3.24	9	3.35	3.40	16.72	2	1.97	-39.20	119.80
	3	7.75	9	7.20	-7.10	28.33	3	5.91	-23.74	61.08
	4	11.34	9	10.63	-6.26	17.59	3	11.23	-0.97	10.77
	5	18.73	9	17.49	-6.62	15.78	3	18.01	-3.84	9.33
	6	25.59	9	23.33	-8.83	11.62	3	24.19	-5.47	4.96
0884	1	1.98	10	3.04	52.54	26.32	2	2.28	15.15	21.49
	2	3.54	10	4.30	21.47	24.42	2	3.40	-3.95	10.29
	3	11.58	10	12.15	4.92	5.10	3	11.68	0.86	9.67
	4	25.88	10	25.01	3.36	7.36	3	23.62	-8.73	13.76
	5	18.64	10	19.09	2.41	7.70	3	17.06	-8.48	11.20
	6	5.04	10	6.76	34.13	42.16	2	5.51	9.33	2.90
				B. OUTLIERS REMOVED						
0284	1	1.72	8	2.39	38.95	41.84	2	1.50	0.00	130.00
	2	3.24	9	3.35	3.40	16.72	2	1.97	-39.20	119.80
	3	7.75	8	7.81	0.77	12.42	3	5.91	-23.74	61.08
	4	11.34	8	11.17	-1.50	8.86	3	11.23	-0.97	10.77
	5	18.73	9	17.49	-6.62	15.78	3	18.01	-3.84	9.33
	6	25.59	9	23.33	-8.83	11.62	3	24.19	-5.47	4.96
0884	1	1.98	10	3.04	53.64	26.32	2	2.28	15.15	21.49
	2	3.54	10	4.30	21.47	24.42	2	3.40	-3.95	10.25
	3	11.58	10	12.15	4.92	5.10	3	11.68	0.86	9.67
	4	25.88	9	24.50	-5.33	3.88	3	23.62	-8.73	14.18
	5	18.64	10	19.09	2.41	7.70	3	17.06	-8.48	11.20
	6	5.04	10	5.91	17.26	17.09	2	5.51	9.33	2.90

TABLE 13. AUDIT RESULTS FOR SULFATE BY THE AUTOMATED METHODS

Audit	Level	Assigned value ($\mu g/m^3$)	Methyl Thymol Blue (16) n	Mean ($\mu g/m^3$)	% Acc.	% CV	Ion Chromatograph (34) n	Mean ($\mu g/m^3$)	% Acc.	% CV
				A. ALL DATA						
0284	1	1.72	24	2.26	31.40	78.31	13	1.89	9.88	14.29
	2	3.24	24	3.50	0.02	34.00	14	3.78	16.67	30.95
	3	7.75	24	8.60	10.97	49.88	14	8.29	6.97	17.73
	4	11.34	24	11.16	-1.59	8.78	14	11.15	-1.68	35.25
	5	18.73	24	18.03	-3.74	10.93	14	19.09	1.92	10.63
	6	25.59	24	24.08	-5.90	16.36	14	25.88	1.13	10.12
0884	1	1.98	22	2.12	7.07	25.00	15	2.43	22.73	42.39
	2	3.54	22	3.45	-2.54	12.17	15	3.95	11.58	55.19
	3	11.58	23	11.96	3.28	5.27	15	14.62	26.25	54.31
	4	25.88	23	25.53	-1.36	6.46	15	28.98	11.98	59.90
	5	18.64	23	18.91	1.46	5.71	15	20.89	12.07	62.18
	6	5.04	22	5.78	14.68	10.59	15	6.38	26.59	58.62
				B. OUTLIERS REMOVED						
0284	1	1.72	22	1.85	7.56	24.86	11	1.88	9.30	7.45
	2	3.24	21	3.28	1.23	12.80	12	3.33	2.78	7.21
	3	7.75	21	7.73	-0.26	5.69	12	7.73	-0.26	3.36
	4	11.34	23	11.14	-1.76	6.10	12	11.39	0.44	7.90
	5	18.73	23	18.37	-1.92	5.82	12	18.42	-1.66	5.81
	6	25.59	22	24.06	-5.98	9.19	12	26.06	1.84	7.25
0884	1	1.98	21	2.03	2.53	14.78	12	2.09	5.56	4.78
	2	3.54	21	3.39	-4.24	9.14	13	3.49	-1.41	5.44
	3	11.58	23	11.96	3.28	5.27	12	11.66	0.69	4.97
	4	25.88	22	25.74	-0.54	5.32	12	25.75	-0.50	2.72
	5	18.64	23	18.91	1.45	5.71	12	18.38	-1.39	3.37
	6	5.04	22	5.38	6.76	10.59	12	4.98	-1.19	5.42

TABLE 14. PERCENTAGE OF SULFATE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0284	1	1.72	29.1	50.9	63.6	76.4
	2	3.24	45.5	70.9	81.8	87.3
	3	7.75	76.4	87.3	90.9	92.7
	4	11.34	81.8	89.1	94.5	96.4
	5	18.73	76.4	90.9	96.4	100.0
	6	25.59	67.3	87.3	96.4	100.0
0884	1	1.98	49.1	67.9	71.7	81.1
	2	3.54	56.6	77.4	81.1	90.6
	3	11.58	61.1	96.2	96.2	96.2
	4	25.88	84.9	94.3	96.2	96.2
	5	18.64	83.0	94.3	98.2	96.2
	6	5.04	62.3	79.2	83.0	88.7
		B. OUTLIERS REMOVED				
0284	1	1.72	36.2	50.9	64.2	77.4
	2	3.24	45.5	73.6	84.9	90.6
	3	7.75	79.2	90.6	94.3	96.2
	4	11.34	84.9	92.5	96.2	98.1
	5	18.73	79.2	94.0	98.1	100.0
	6	25.59	69.8	88.7	98.1	100.0
0884	1	1.98	50.9	70.6	74.5	84.3
	2	3.54	58.8	80.3	84.3	92.1
	3	11.58	84.3	100.0	100.0	100.0
	4	25.88	88.2	98.0	100.0	100.0
	5	18.64	86.3	98.0	100.0	100.0
	6	5.04	64.7	82.4	86.3	92.2

TABLE 15. AUDIT RESULTS FOR NITRATE ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0284	1	43	0.85	1.25	47.06	107.20
	2	45	2.00	2.26	13.00	34.50
	3	45	5.42	5.48	1.11	20.43
	4	45	8.89	8.48	-4.61	25.23
	5	45	11.69	11.29	-3.42	15.77
	6	45	13.93	13.06	-6.26	18.30
0884	1	43	0.74	0.99	33.78	68.69
	2	43	2.09	2.36	12.92	61.86
	3	44	5.46	6.12	12.09	60.29
	4	44	9.83	10.62	8.04	63.37
	5	44	11.38	12.54	10.19	62.68
	6	44	13.44	14.82	10.29	67.11
			B. OUTLIERS REMOVED			
0284	1	41	0.85	1.07	25.88	27.10
	2	42	2.00	2.26	13.00	20.35
	3	41	5.42	5.56	2.58	8.63
	4	41	8.89	9.02	1.46	11.53
	5	42	11.69	11.69	0.00	6.50
	6	42	13.93	13.49	-3.16	11.71
0884	1	35	0.74	0.83	12.16	19.07
	2	34	2.09	2.15	2.87	16.46
	3	35	5.46	5.41	-0.92	9.06
	4	35	9.83	9.64	-1.93	6.85
	5	35	11.38	11.44	0.53	5.16
	6	37	13.44	13.49	0.37	7.12

TABLE 16. AUDIT RESULTS FOR NITRATE BY THE AUTOMATED METHODS

Audit	Level	Assigned value ($\mu g/m^3$)	Ion Chromatograph (34) n	Mean ($\mu g/m^3$)	% Acc.	% CV	Cadium Reduction (12) n	Mean ($\mu g/m^3$)	% Acc.	% CV
				A. ALL DATA						
0284	1	0.85	11	1.06	24.71	22.64	21	1.41	65.80	135.46
	2	2.00	12	2.24	12.00	20.54	21	2.27	13.50	41.41
	3	5.42	12	5.68	4.80	7.92	21	5.33	-1.66	28.71
	4	8.89	12	8.35	-6.07	29.22	21	8.21	-7.65	29.84
	5	11.69	12	11.65	-0.34	5.66	21	10.85	-7.19	21.57
	6	13.93	12	14.00	0.50	10.57	21	12.45	-10.62	23.69
0884	1	0.74	13	0.92	24.32	46.74	16	1.00	35.14	78.00
	2	2.09	13	1.99	-4.78	19.60	16	2.64	26.32	65.91
	3	5.46	13	5.60	2.56	22.14	17	6.73	23.26	68.20
	4	9.83	13	9.27	-5.70	13.27	17	12.08	22.89	66.64
	5	11.38	13	11.39	0.09	4.30	17	14.27	25.40	64.54
	6	13.44	13	13.17	-2.01	6.30	17	16.69	24.18	62.49
				B. OUTLIERS REMOVED						
0284	1	0.85	10	1.01	18.82	17.82	19	1.04	22.35	2.98
	2	2.00	11	2.15	7.50	17.67	19	2.17	8.50	12.90
	3	5.42	11	5.58	2.85	5.38	19	5.29	-2.40	13.23
	4	8.89	11	9.05	1.80	4.64	19	8.86	-0.34	15.46
	5	11.69	11	11.79	0.86	10.57	19	11.54	-1.28	6.85
	6	13.93	12	14.00	0.50	10.57	19	13.24	-4.95	12.01
0884	1	0.74	12	0.82	10.81	30.49	14	0.78	5.41	11.54
	2	2.09	12	2.09	0.00	6.70	14	2.17	3.83	8.76
	3	5.46	12	5.27	-3.48	7.97	15	5.47	0.18	8.76
	4	9.83	12	9.61	-2.24	2.08	15	9.87	0.41	7.60
	5	11.38	12	11.27	-0.97	2.22	15	11.58	1.76	3.97
	6	13.44	12	13.36	-0.60	3.74	15	13.78	2.53	7.18

TABLE 17. PERCENTAGE OF NITRATE MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0284	1	0.85	24.4	46.7	57.8	75.6
	2	2.00	55.6	68.9	68.9	86.7
	3	5.42	75.6	88.9	91.1	95.6
	4	8.89	80.0	86.7	86.7	93.3
	5	11.69	80.0	91.1	95.6	97.8
	6	13.93	66.7	86.7	91.1	95.6
0884	1	0.74	45.5	59.1	63.6	68.2
	2	2.09	61.4	68.2	72.7	79.5
	3	5.46	59.1	77.3	81.8	86.4
	4	9.83	72.7	79.5	81.8	88.4
	5	11.38	75.0	79.5	81.8	81.8
	6	13.44	70.5	77.3	81.8	81.8
		B. OUTLIERS REMOVED				
0284	1	0.85	25.6	48.8	60.4	79.1
	2	2.00	58.1	72.1	83.7	90.7
	3	5.42	79.1	90.7	93.0	97.7
	4	8.89	80.0	88.4	88.4	95.3
	5	11.69	80.0	95.3	97.7	100.0
	6	13.93	69.8	88.4	93.0	97.7
0884	1	0.74	54.1	70.3	75.7	81.1
	2	2.09	73.0	81.1	86.5	91.9
	3	5.46	70.3	91.9	94.6	97.3
	4	9.83	86.4	91.9	94.6	100.0
	5	11.38	89.2	94.6	94.6	94.6
	6	13.44	83.8	91.9	94.6	94.6

TABLE 18. AUDIT RESULTS FOR LEAD ON FILTER STRIPS

Audit	Level	n	Assigned value ($\mu g/m^3$)	Mean ($\mu g/m^3$)	% Acc.	% CV
			A. ALL DATA			
0184	1	103	0.61	0.58	-4.92	12.06
	2	104	1.20	1.17	-2.50	15.36
	3	103	2.69	2.62	-2.60	6.49
	4	104	2.99	3.01	0.67	17.39
	5	104	5.51	5.29	-3.99	8.88
	6	104	7.39	6.95	-5.98	10.50
0784	1	102	0.75	0.73	-2.67	22.00
	2	102	2.21	2.06	-6.79	13.11
	3	102	2.51	2.37	-5.58	10.55
	4	102	4.05	3.86	-4.69	10.62
	5	101	4.34	4.16	-4.16	11.06
	6	102	7.10	6.85	-3.52	11.39
			B. OUTLIERS REMOVED			
0184	1	95	0.61	0.58	-4.92	8.62
	2	97	1.20	1.15	-4.17	6.96
	3	96	2.69	2.62	-2.60	4.96
	4	98	2.99	2.95	-1.34	7.46
	5	97	5.51	5.27	-4.36	5.12
	6	95	7.39	7.04	-4.74	3.98
0784	1	97	0.75	0.73	-2.67	6.80
	2	97	2.21	2.10	-4.98	5.71
	3	96	2.51	2.39	-4.78	4.60
	4	96	4.05	3.91	-3.46	4.09
	5	93	4.34	4.21	-3.00	4.28
	6	94	7.10	7.01	-1.27	4.28

TABLE 19. PERCENTAGE OF LEAD MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE

Audit	Level	Assigned value ($\mu g/m^3$)	10%	20%	30%	50%
		A. ALL DATA				
0184	1	0.61	73.1	90.4	96.2	98.1
	2	1.20	78.8	93.3	98.1	99.0
	3	2.69	87.5	98.1	99.0	99.0
	4	2.99	87.5	95.2	96.2	98.1
	5	5.51	83.7	95.2	98.1	100.0
	6	7.39	85.6	95.2	99.0	99.0
0784	1	0.75	77.5	96.1	98.0	98.0
	2	2.21	85.3	95.0	98.0	98.0
	3	2.51	83.3	97.1	99.0	99.0
	4	4.05	87.3	99.0	99.0	99.0
	5	4.34	82.4	97.0	97.0	98.0
	6	7.10	87.3	95.1	99.0	99.0
		B. OUTLIERS REMOVED				
0184	1	0.61	75.8	90.9	96.0	98.0
	2	1.20	81.8	94.9	99.0	100.0
	3	2.69	90.9	98.0	99.0	99.0
	4	2.99	90.0	96.0	97.0	99.0
	5	5.51	86.9	96.0	99.0	100.0
	6	7.39	88.9	97.0	100.0	100.0
0784	1	0.75	80.6	98.9	98.9	98.9
	2	2.21	88.8	96.9	98.9	98.6
	3	2.51	86.7	100.0	100.0	100.0
	4	4.05	90.8	100.0	100.0	100.0
	5	4.34	85.7	98.9	98.9	98.9
	6	7.10	90.8	95.9	100.0	100.0

TABLE 20. AUDIT RESULTS FOR SULFUR DIOXIDE CONTINUOUS MONITORS (ALL DATA)

Flow setting	Number of reported values*	Range of values (ppm)	Mean differences ppm	Mean differences % diff.	Standard deviation (ppm)
1	29	0.577 to 0.702	0.004	0.4	0.066
2	216	0.377 to 0.513	0.006	1.6	0.033
3	219	0.200 to 0.270	0.004	1.7	0.016
4	220	0.151 to 0.206	0.003	2.0	0.013
5	220	0.040 to 0.073	0.002	3.2	0.006
6	156	0.000	0.001	--	0.003

*1984 Audit: Data returned for 221 monitors

TABLE 21. AUDIT RESULTS FOR SULFUR DIOXIDE CONTINUOUS MONITORS BY VARIOUS INSTRUMENTAL METHODS

Flow setting	Flame photometric average difference n	Flame photometric average difference ppm	Flame photometric average difference %	Fluorescent average difference n	Fluorescent average difference ppm	Fluorescent average difference %	Coulometric average difference n	Coulometric average difference ppm	Coulometric average difference %
1	0	---	---	28	0.003	0.3	0	---	---
2	8	0.008	2.0	201	0.006	1.5	4	-0.000	0.1
3	8	0.010	4.6	203	0.003	1.5	5	0.004	1.7
4	8	0.008	5.0	204	0.003	1.8	5	0.003	1.5
5	8	0.003	6.0	204	0.002	3.2	5	0.000	-0.6
6	7	0.002	---	145	0.001	---	2	0.000	---

TABLE 22. AUDIT RESULTS FOR HIGH-VOLUME FLOW RATE

Method	No. of results	Results within indicated % of assigned value			
		20%	40%	60%	80%
Rotameter (visifloat)	1233[1]	1.59	3.11	5.28	8.42
Pressure transducer (continuous)	2428[2]	1.08	2.37	3.87	6.25
Flow controller	169[3]	0.71	1.44	2.55	3.66
Pressure transducer/flow controller	236[4]	1.63	3.18	4.65	6.82
Other methods	836[5]	1.96	3.63	5.24	7.85
All methods	4867[6]	1.30	2.71	4.37	6.85

[1]1317 measurements reported
[2]2594 measurements reported
[3] 183 measurements reported
[4] 240 measurements reported
[5] 902 measurements reported
[6]5236 measurements reported

TABLE 23. PERCENTAGE OF HI-VOL FLOW MEASUREMENTS WITHIN INDICATED PERCENTAGE OF ASSIGNED VALUE (ALL DATA)

Plate number	Number of measurements	Approximate flow (m^3/min)	10%	20%	30%	50%
5	776	0.7	73.1	89.3	95.1	98.7
7	891	0.9	84.2	95.4	97.2	98.0
10	1036	1.1	87.8	96.2	98.4	99.3
13	1011	1.2	90.0	97.4	98.6	99.6
18	1013	1.3	91.2	97.2	98.8	98.9

TABLE 24. ACID RAIN RESULTS FOR pH, CONDUCTIVITY AND ACIDITY (ALL DATA)

Audit		Level	n	Assigned value	Mean	% Acc.	% CV
0484	pH	1	36	4.28	4.27	-0.23	4.23
		2	36	4.01	3.98	-0.75	3.92
		3	36	3.55	3.54	-0.28	2.94
	Conductivity (µS/cm)	1	32	24.00	22.51	-6.21	22.03
		2	32	50.70	49.51	-2.35	30.67
		3	32	136.20	124.63	-8.49	10.82
	Acidity (µequiv/L)	1	20	52.80	51.29	-2.86	54.59
		2	20	102.00	95.17	-6.70	51.67
		3	20	304.40	261.46	-14.11	48.23
1084	pH	1	32	4.28	4.24	-0.93	5.51
		2	32	3.88	3.86	-0.52	4.53
		3	32	3.73	3.711	-0.54	3.93
	Conductivity (µS/cm)	1	29	24.40	37.35	53.07	202.29
		2	29	66.00	86.50	31.06	124.90
		3	29	92.70	90.92	-1.92	9.30
	Acidity (µequiv/L)	1	16	53.10	74.76	40.79	35.52
		2	16	137.20	157.05	14.47	16.31
		3	16	197.00	217.05	10.18	12.59

TABLE 25. ACID RAIN RESULTS FOR pH, CONDUCTIVITY AND ACIDITY (OUTLIERS REMOVED)

Audit		Level	n	Assigned value	Mean	% Acc.	% CV
0484	pH	1	34	4.28	4.27	-0.23	4.23
		2	34	4.01	3.98	-0.75	3.12
		3	34	3.55	3.54	-0.28	1.81
	Conductivity (µS/cm)	1	30	24.00	22.33	-6.96	10.47
		2	31	50.70	47.00	-7.30	11.47
		3	31	136.20	126.51	-7.11	6.68
	Acidity (µequiv/L)	1	20	52.80	51.29	-2.86	54.59
		2	20	102.00	95.17	-6.70	51.67
		3	20	304.40	201.46	-33.80	48.23
1084	pH	1	30	4.28	4.30	0.47	1.39
		2	30	3.88	3.90	0.52	1.13
		3	30	3.73	3.75	0.54	1.07
	Conductivity (µS/cm)	1	28	24.40	23.33	-4.39	10.93
		2	28	66.00	66.73	1.11	28.25
		3	28	92.70	89.89	-3.03	7.22
	Acidity (µequiv/L)	1	16	53.10	74.76	40.79	35.52
		2	15	137.20	152.19	10.83	11.33
		3	15	197.00	212.99	8.12	10.68

TABLE 26. ACID RAIN AUDIT RESULTS FOR ANIONS (ALL DATA)

Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0484	SO_4 (reported as S)	1	28	0.81	0.86	6.17	40.67
		2	32	2.11	2.43	15.17	43.32
		3	32	3.68	3.87	5.16	33.70
	NO_3 (reported as N)	1	30	0.11	0.12	9.09	20.69
		2	30	0.11	0.16	45.45	128.57
		3	30	1.55	1.47	-5.16	25.34
	Cl	1	29	0.28	0.32	14.29	54.11
		2	29	0.41	0.42	2.44	56.77
		3	29	1.26	1.18	-6.35	22.93
	F	1	22	0.04	0.05	25.00	51.11
		2	22	0.08	0.08	0.00	44.87
		3	22	0.25	0.26	4.00	14.06
1084	SO_4 (reported as S)	1	29	0.87	1.03	18.39	65.53
		2	29	2.75	3.11	13.09	41.77
		3	29	3.68	4.21	14.40	38.55
	NO_3 (reported as N)	1	28	0.12	0.11	-8.33	26.79
		2	28	0.12	0.12	0.00	21.01
		3	28	0.14	0.14	0.00	21.48
	Cl	1	29	0.29	0.46	58.62	191.32
		2	29	0.63	0.91	44.44	191.79
		3	29	0.92	1.14	23.91	100.88
	F	1	21	0.03	0.04	33.33	68.42
		2	21	0.09	0.08	-11.11	30.95
		3	21	0.26	0.26	0.00	13.36

TABLE 27. ACID RAIN AUDIT RESULTS FOR ANIONS (OUTLIERS REMOVED)

Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0484	SO_4 (reported as S)	1	27	0.81	0.80	-1.23	15.60
		2	30	2.11	2.20	4.27	24.09
		3	30	3.68	3.57	-2.99	15.85
	NO_3 (reported as N)	1	29	0.11	0.11	0.00	17.54
		2	29	0.11	0.12	9.09	24.19
		3	29	1.55	1.52	-1.94	23.10
	Cl	1	28	0.28	0.29	3.57	38.36
		2	28	0.41	0.38	-7.52	31.67
		3	27	1.26	1.19	-5.56	17.30
	F	1	21	0.04	0.04	0.00	46.51
		2	22	0.08	0.08	0.00	44.87
		3	21	0.25	0.26	4.00	8.81
1084	SO_4 (reported as S)	1	27	0.87	0.87	0.00	33.45
		2	27	2.75	2.76	0.36	5.93
		3	27	3.68	3.78	2.72	6.51
	NO_3 (reported as N)	1	26	0.12	0.12	0.00	11.76
		2	27	0.12	0.12	0.00	12.20
		3	27	0.14	0.14	0.00	12.14
	Cl	1	28	0.29	0.30	3.45	42.47
		2	28	0.63	0.59	-6.35	24.79
		3	28	0.92	0.93	1.09	25.97
	F	1	20	0.03	0.03	0.00	61.76
		2	20	0.09	0.09	0.00	20.45
		3	20	0.26	0.27	3.85	11.28

TABLE 28. ACID RAIN RESULTS FOR CATIONS (ALL DATA)

Audit		Level	n	Assigned value (mg/1)	Mean (mg/1)	% Acc.	% CV
0484	NH_4 (reported as N)	1	27	0.08	0.38	375.00	396.82
		2	27	0.63	0.64	1.59	15.43
		3	27	0.80	0.84	5.00	15.67
	Ca	1	25	0.06	0.06	0.00	46.77
		2	25	0.01	0.03	200.00	126.47
		3	25	0.12	0.11	-8.33	24.78
	K	1	24	0.07	0.08	14.29	35.80
		2	24	0.09	0.07	-22.22	34.38
		3	24	0.09	0.10	11.11	53.54
	Mg	1	24	0.02	0.02	0.00	28.57
		2	23	0.01	0.01	0.00	135.71
		3	25	0.04	0.04	0.00	33.33
	Na	1	26	0.19	0.26	36.84	99.61
		2	26	0.24	0.35	45.83	91.09
		3	26	0.49	0.55	12.24	51.00
1084	NH_4 (reported as N)	1	27	0.08	0.08	0.00	35.44
		2	27	0.61	0.63	3.28	15.77
		3	27	0.79	0.81	2.53	14.96
	Ca	1	26	0.05	0.10	100.00	139.60
		2	26	0.13	0.17	30.77	52.30
		3	26	0.01	0.05	400.00	242.59
	K	1	26	0.07	0.09	28.57	113.19
		2	26	0.08	0.09	12.50	26.60
		3	26	0.10	0.12	20.00	77.50
	Mg	1	25	0.02	0.02	0.00	47.37
		2	25	0.01	0.01	0.00	75.00
		3	25	0.04	0.04	0.00	36.84
	Na	1	26	0.19	0.18	-5.26	28.80
		2	26	0.25	0.27	8.00	51.28
		3	26	0.49	0.49	0.00	27.85

TABLE 29. ACID RAIN AUDIT RESULTS FOR CATIONS (OUTLIERS REMOVED)

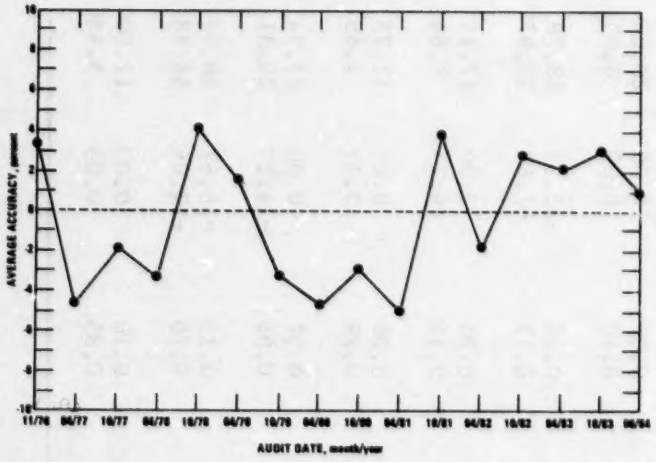
Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0484	NH_4 (reported as N)	1	26	0.08	0.09	12.51	49.44
		2	25	0.63	0.63	0.00	8.52
		3	25	0.80	0.84	5.00	9.81
	Ca	1	23	0.06	0.05	16.70	16.67
		2	23	0.01	0.02	100.00	86.96
		3	24	0.12	0.11	-8.30	19.27
	K	1	23	0.07	0.08	14.30	26.32
		2	23	0.09	0.10	11.10	27.00
		3	23	0.09	0.09	0.00	39.56
	Mg	1	23	0.02	0.02	0.00	25.00
		2	22	0.01	0.01	0.00	40.00
		3	24	0.04	0.04	0.00	20.51
	Na	1	25	0.19	0.22	15.80	73.73
		2	25	0.24	0.30	25.00	68.00
		3	24	0.49	0.48	-2.04	14.32
1084	NH_4 (reported as N)	1	26	0.08	0.08	0.00	28.05
		2	25	0.61	0.63	3.20	8.37
		3	25	0.79	0.81	2.53	8.61
	Ca	1	25	0.05	0.08	60.00	100.00
		2	25	0.13	0.17	30.80	48.48
		3	25	0.01	0.03	200.00	174.19
	K	1	25	0.07	0.07	11.40	38.03
		2	24	0.08	0.09	12.50	19.35
		3	25	0.10	0.10	0.00	25.24
	Mg	1	25	0.02	0.02	0.00	47.37
		2	24	0.01	0.01	0.00	70.00
		3	23	0.04	0.04	0.00	19.51
	Na	1	25	0.19	0.18	-5.26	17.71
		2	25	0.25	0.25	0.00	26.61
		3	25	0.49	0.47	-4.08	19.11

TABLE 30. ACID RAIN AUDIT RESULTS FOR TRACE METALS (ALL DATA)

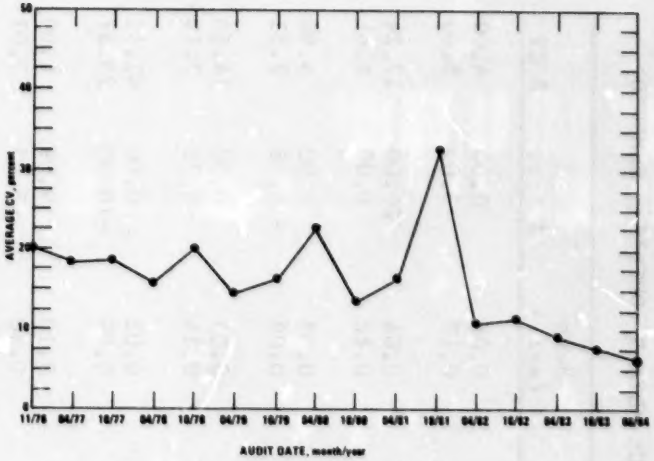
Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0484	Mn	4	17	0.05	0.05	0.00	8.16
		5	19	0.10	0.10	0.00	12.24
	Fe	4	17	0.05	0.05	0.00	14.00
		5	17	0.12	0.12	0.00	10.08
	Cd	4	17	0.03	0.03	0.00	16.67
		5	17	0.11	0.10	-9.09	17.53
	Cu	4	17	0.05	0.05	0.00	29.41
		5	17	0.16	0.15	-6.25	10.39
	Ni	4	15	0.03	0.04	33.33	59.46
		5	16	0.10	0.10	0.00	47.52
	Pb	4	16	0.11	0.10	-9.09	7.07
		5	18	0.31	0.31	0.00	12.34
	Zn	4	17	0.11	0.10	-9.09	11.76
		5	17	0.72	0.71	-1.39	4.40
1084	Mn	4	12	0.05	0.06	20.00	28.81
		5	12	0.10	0.10	0.00	8.16
	Fe	4	11	0.06	0.05	-16.67	74.51
		5	11	0.13	0.12	-7.69	20.97
	Cd	4	12	0.04	0.03	-25.00	37.50
		5	12	0.16	0.15	-6.25	12.84
	Cu	4	12	0.06	0.05	-16.67	34.00
		5	12	0.30	0.30	0.00	6.42
	Ni	4	11	0.07	0.07	0.00	41.54
		5	11	0.07	0.06	-14.29	33.90
	Pb	4	12	0.12	0.10	-16.67	48.96
		5	12	0.23	0.20	-13.04	48.98
	Zn	4	12	0.10	0.11	10.00	20.00
		5	12	0.85	0.87	2.35	8.62

TABLE 31. ACID RAIN AUDIT RESULTS FOR TRACE METALS (OUTLIERS REMOVED)

Audit		Level	n	Assigned value (mg/l)	Mean (mg/l)	% Acc.	% CV
0484	Mn	4	15	0.05	0.05	0.00	4.00
		5	18	0.10	0.10	0.00	5.00
	Fe	4	16	0.05	0.04	-20.00	12.24
		5	16	0.12	0.12	0.00	6.61
	Cd	4	16	0.03	0.03	0.00	6.90
		5	16	0.11	0.09	-18.18	7.53
	Cu	4	16	0.05	0.05	0.00	14.58
		5	16	0.16	0.15	-6.25	7.10
	Ni	4	14	0.03	0.03	0.00	42.42
		5	15	0.10	0.09	-10.00	29.67
	Pb	4	15	0.11	0.10	-9.09	4.95
		5	16	0.31	0.30	-3.23	5.07
	Zn	4	16	0.11	0.10	-9.09	5.77
		5	16	0.72	0.71	-1.39	3.38
1084	Mn	4	11	0.05	0.06	20.00	20.00
		5	11	0.10	0.10	0.00	6.00
	Fe	4	10	0.06	0.04	-33.33	48.78
		5	11	0.13	0.12	-7.69	20.97
	Cd	4	11	0.04	0.04	0.00	17.14
		5	11	0.16	0.15	-6.25	7.84
	Cu	4	11	0.06	0.06	0.00	12.73
		5	11	0.30	0.29	-3.33	4.45
	Ni	4	10	0.07	0.07	0.00	23.94
		5	10	0.07	0.06	-14.29	20.31
	Pb	4	12	0.12	0.10	-16.67	48.90
		5	12	0.23	0.20	-13.04	48.98
	Zn	4	11	0.10	0.10	0.00	12.00
		5	11	0.85	0.85	0.00	5.98

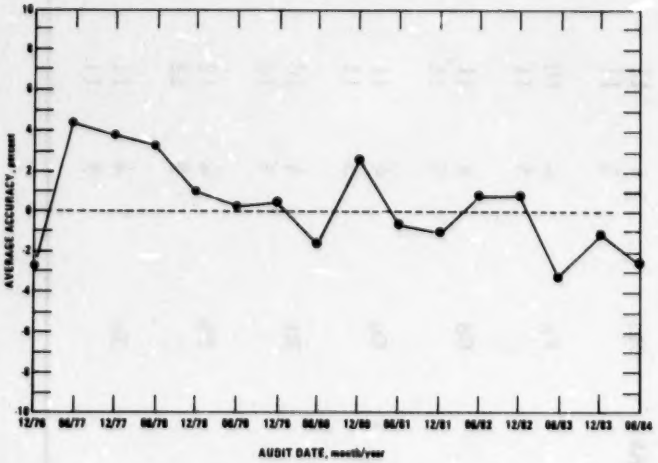


ACCURACY

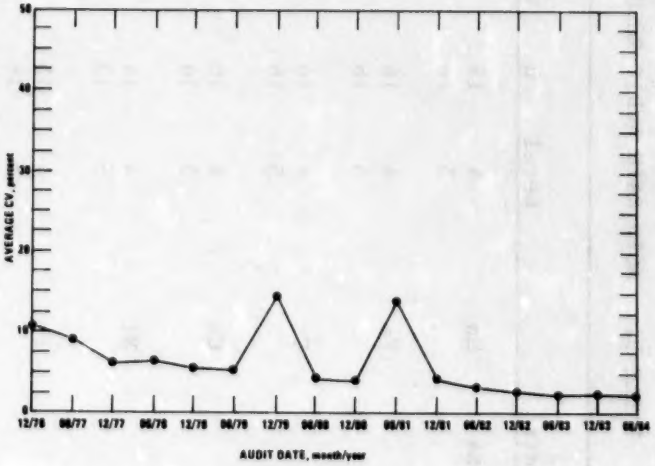


PRECISION

Figure 1. SO_2 bubbler audits.



ACCURACY



PRECISION

Figure 2. NO_2 bubbler audits.

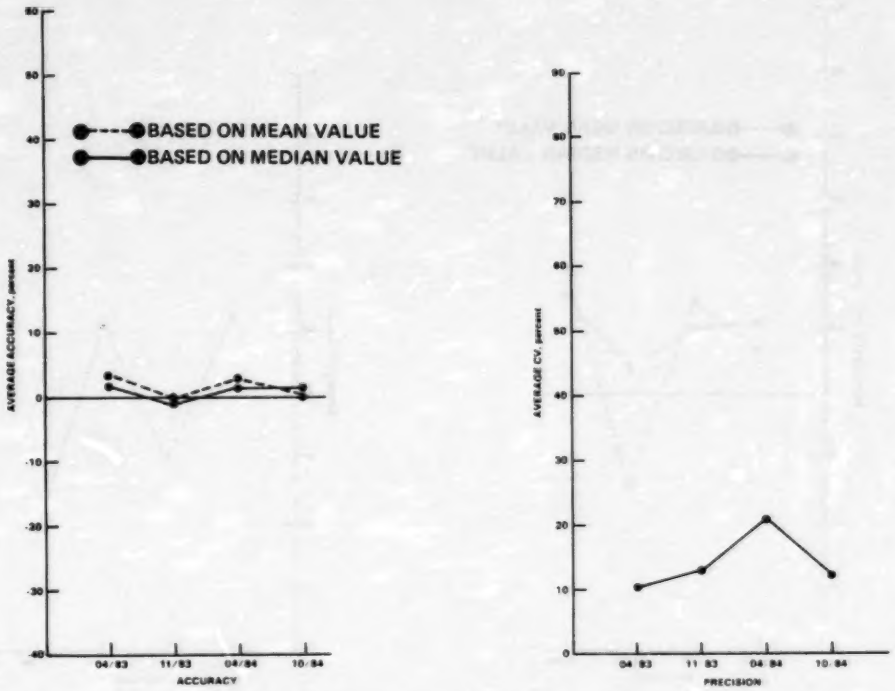


Figure 11. Acid rain audit results for NO_3 (reported as N).

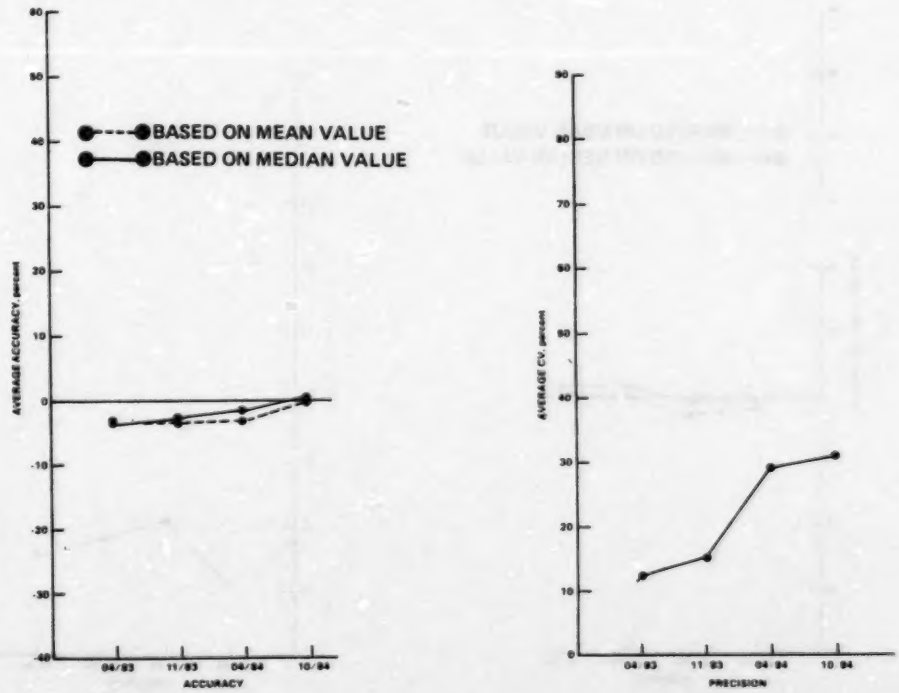


Figure 12. Acid rain audit results for Cl.

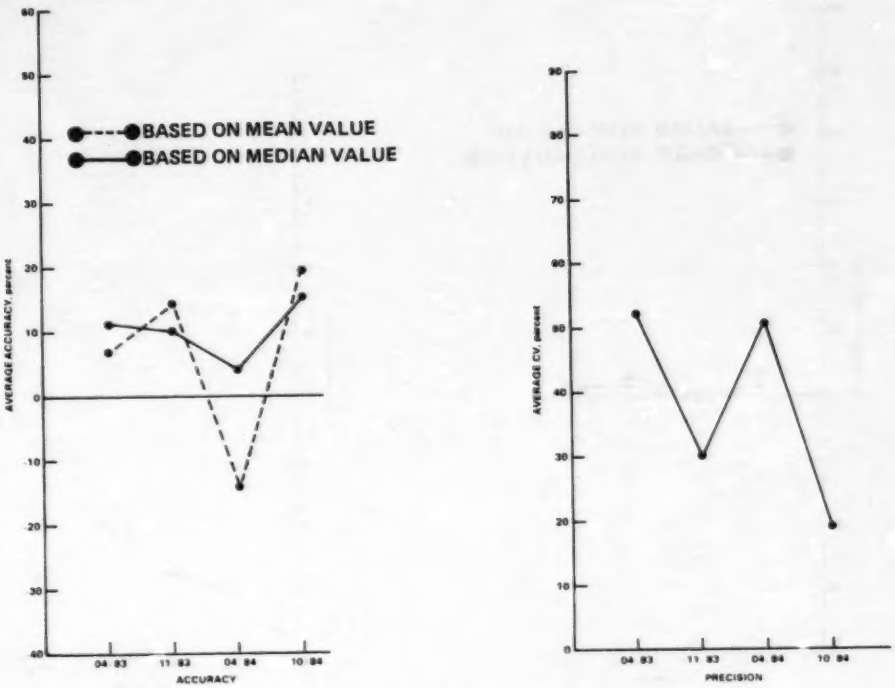


Figure 9. Acid rain audit results for acidity.

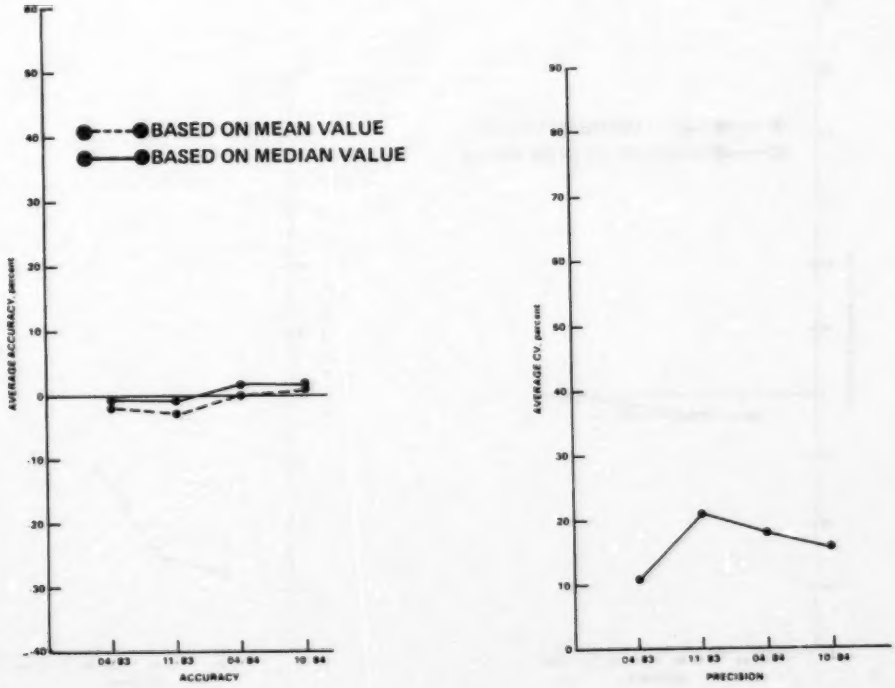


Figure 10. Acid rain audit results for SO_4 (reported as S).

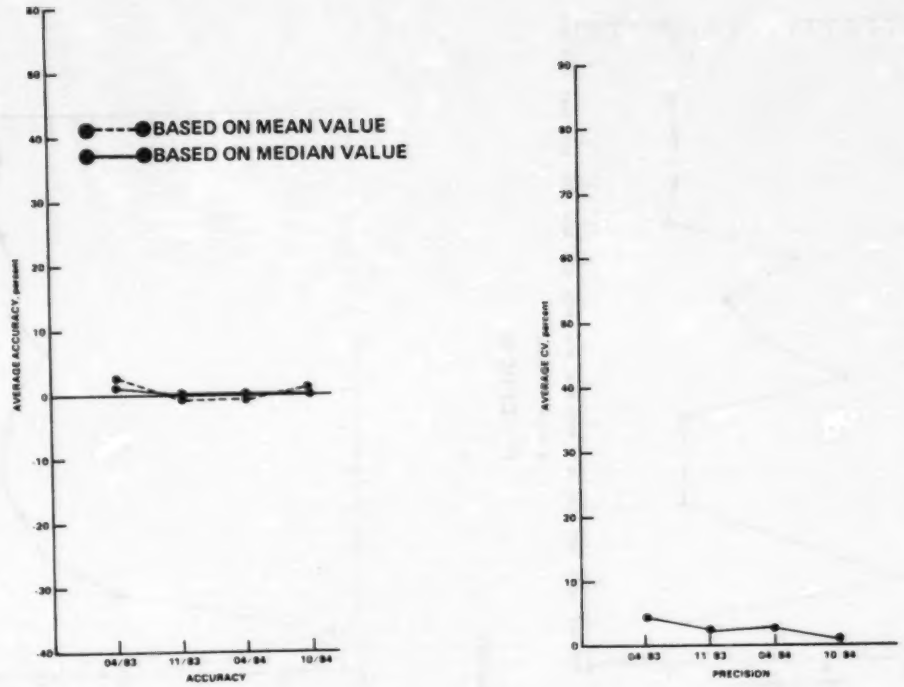


Figure 7. Acid rain audit results for pH.

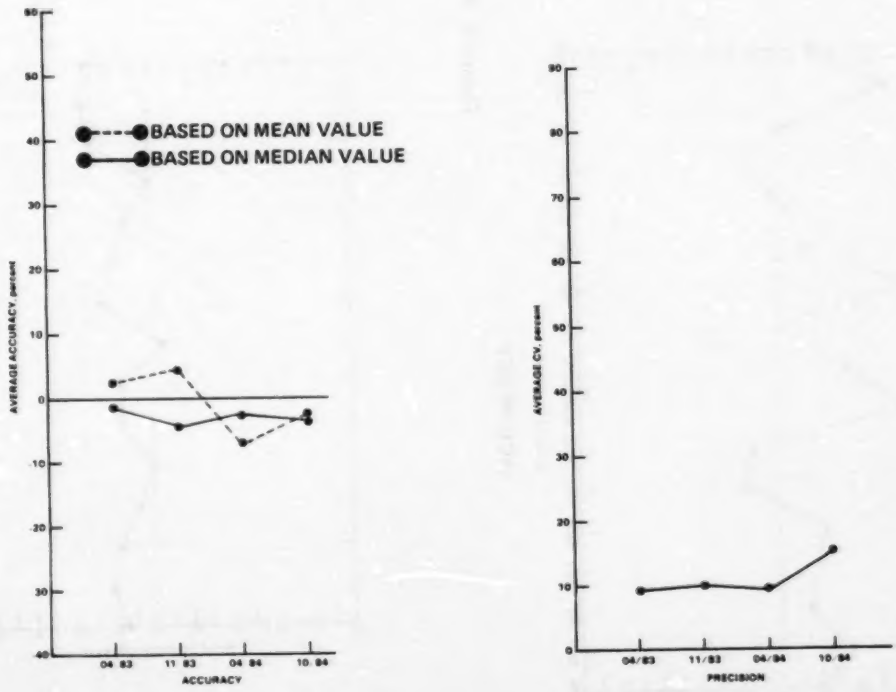
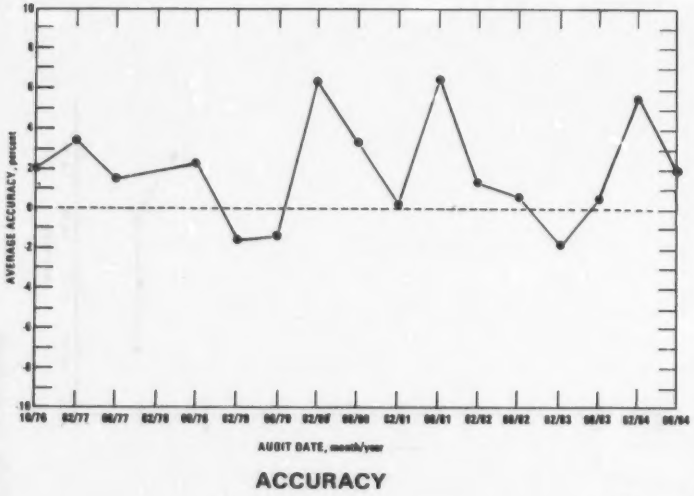
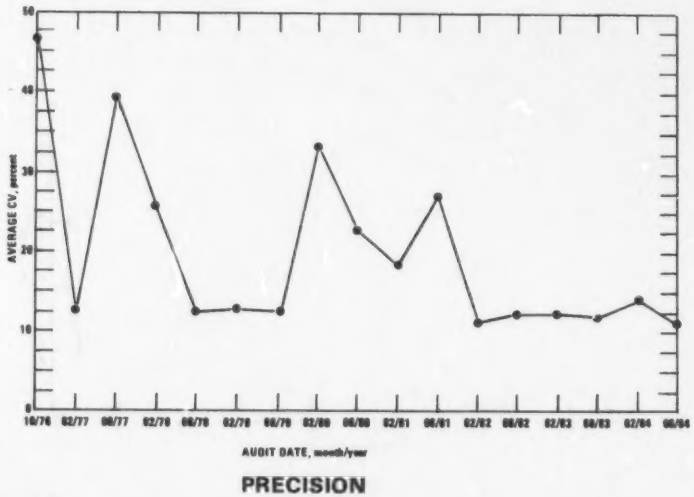


Figure 8. Acid rain audit results for conductivity.

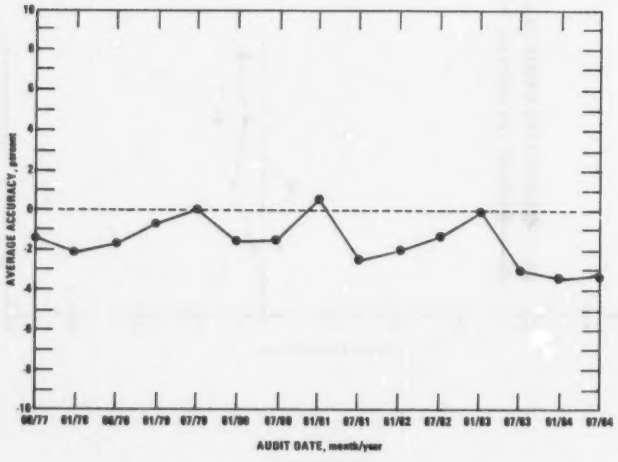


ACCURACY

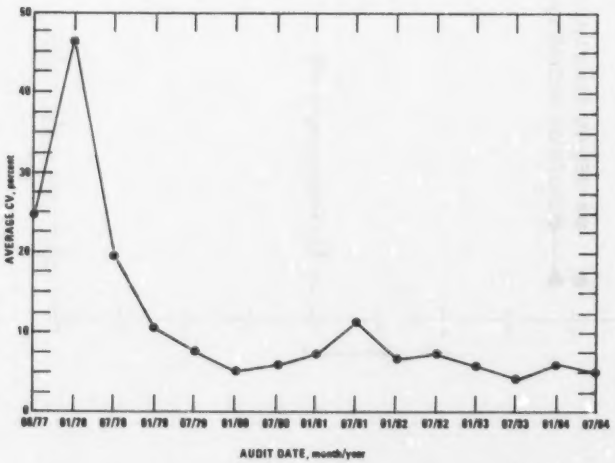


PRECISION

Figure 5. Nitrate audits.

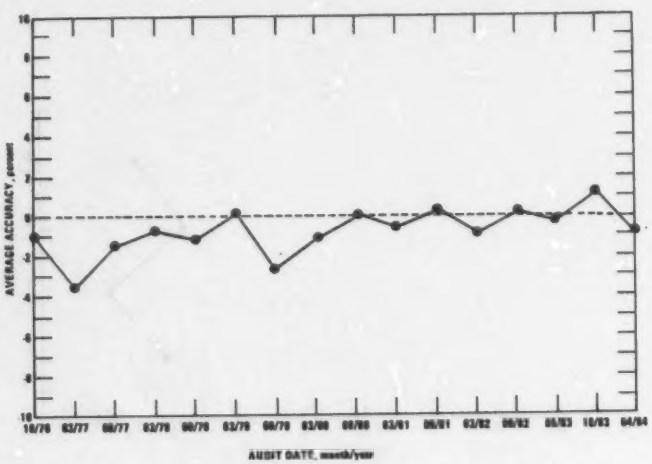


ACCURACY

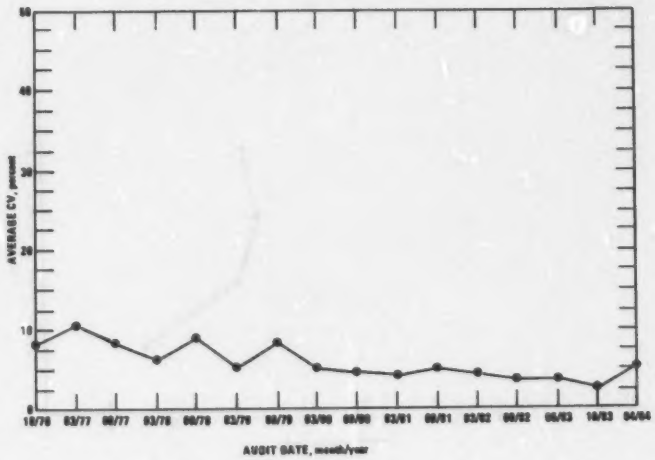


PRECISION

Figure 6. Lead audits.

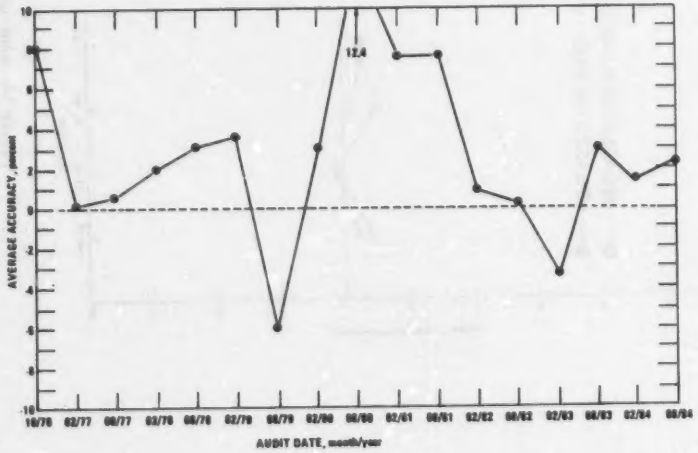


ACCURACY

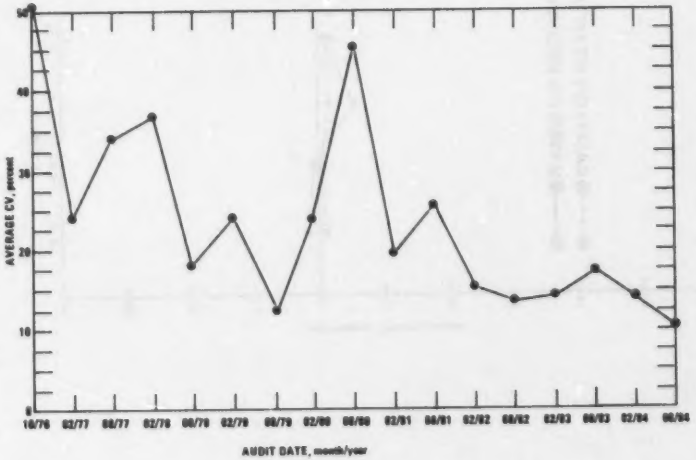


PRECISION

Figure 3. Carbon monoxide audits.



ACCURACY



PRECISION

Figure 4. Sulfate audits.

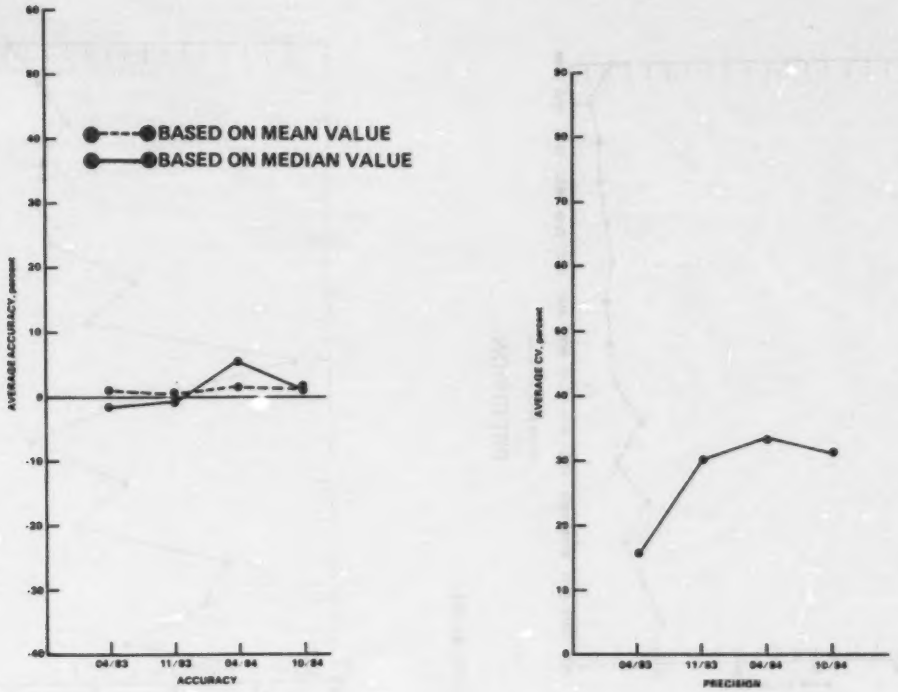


Figure 13. Acid rain audit results for F.

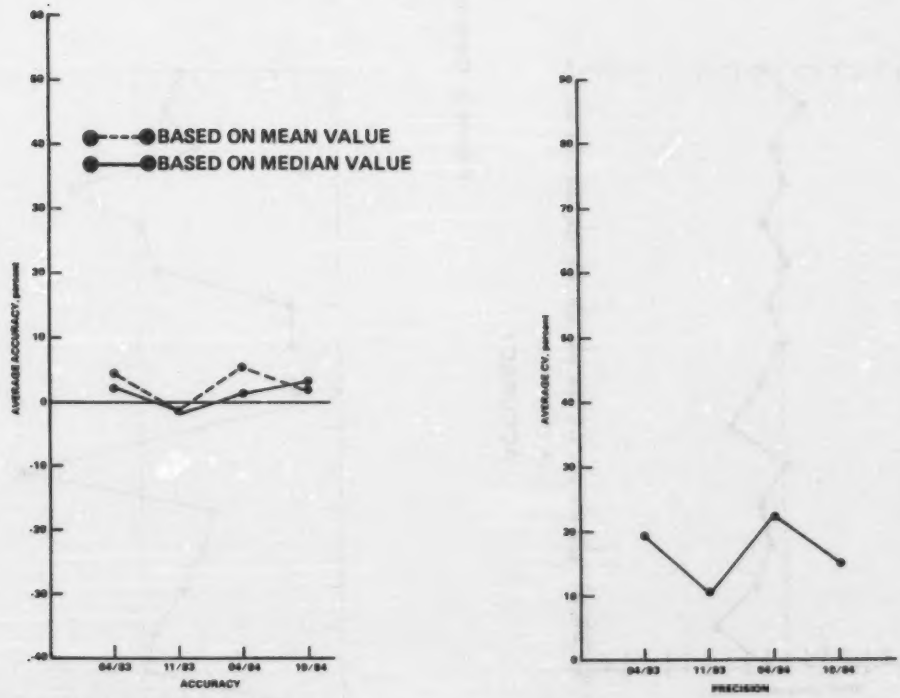


Figure 14. Acid rain audit results for NH_4 (reported as N).

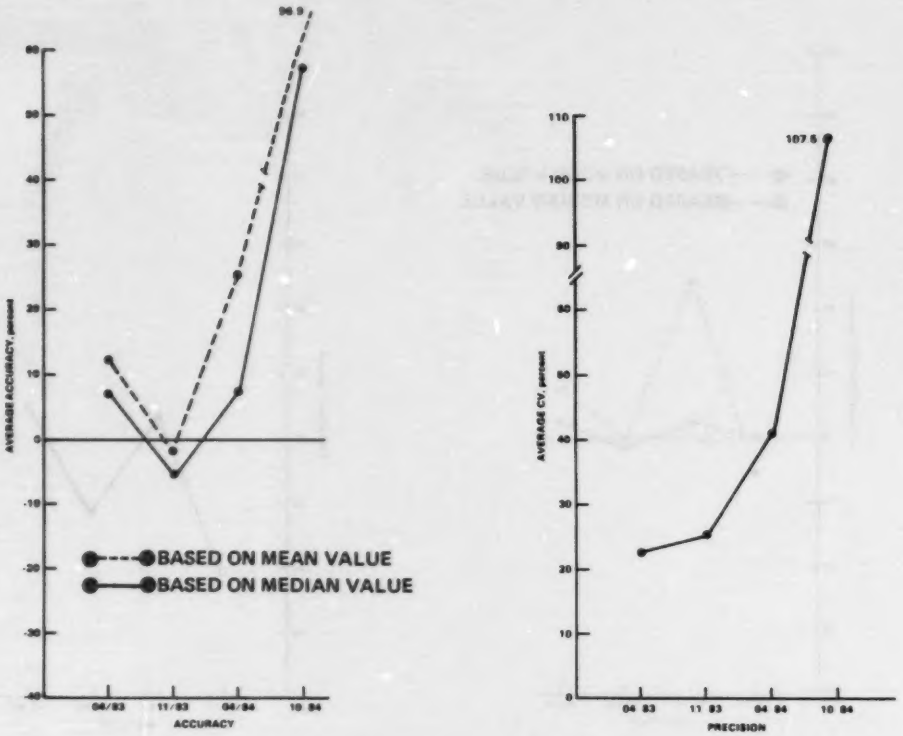


Figure 15. Acid rain audit results for Ca.

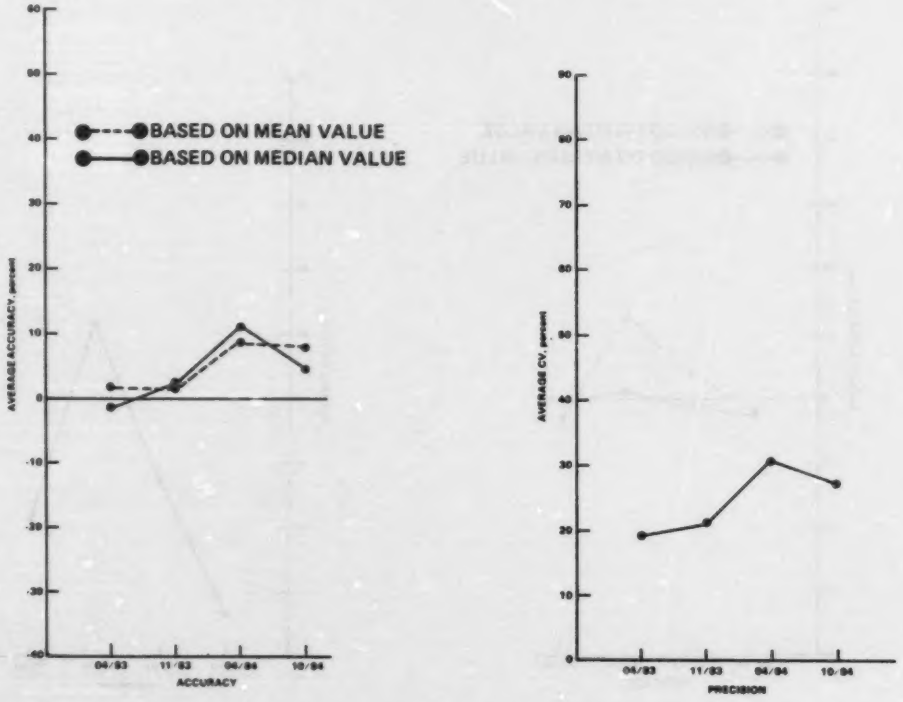


Figure 16. Acid rain audit results for K.

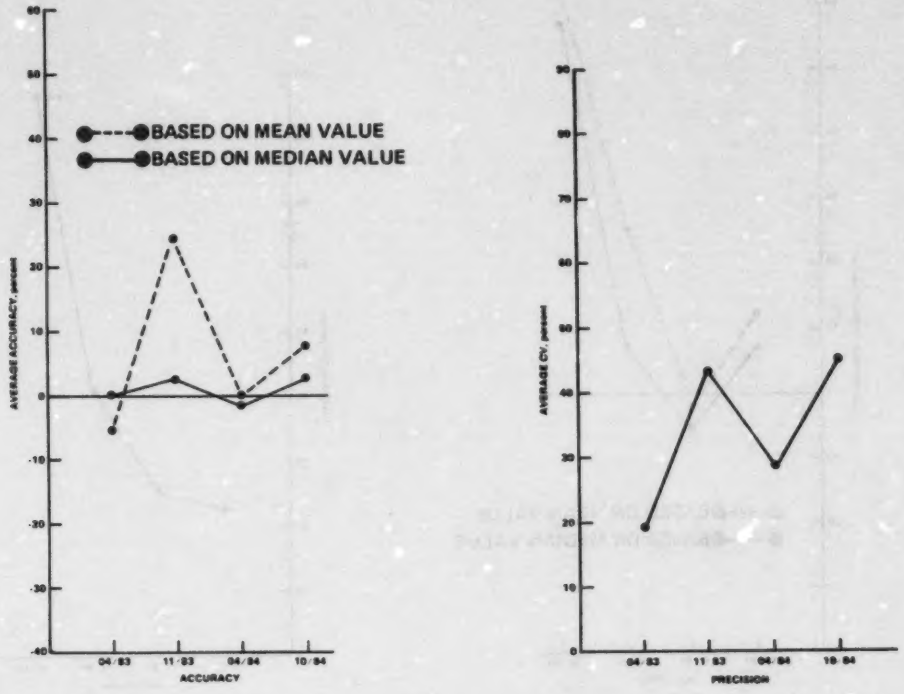


Figure 17. Acid rain audit results for Mg.

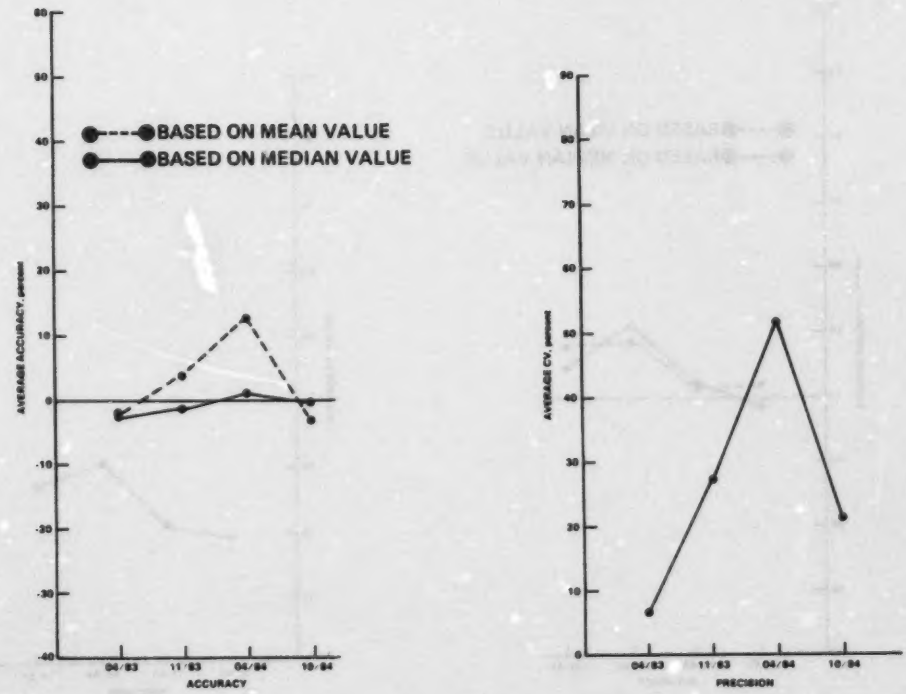


Figure 18. Acid rain audit results for Na.

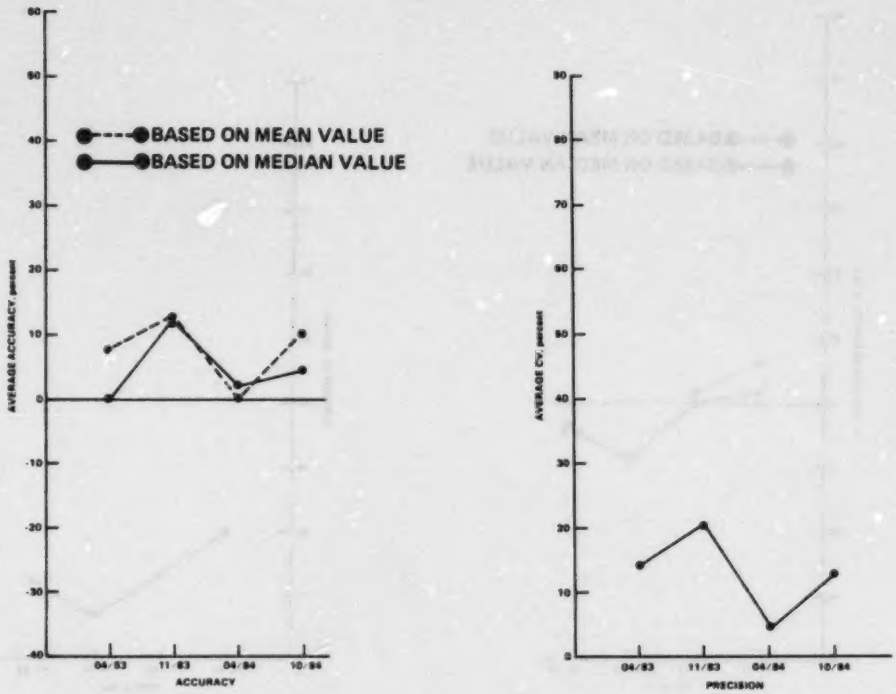


Figure 19. Acid rain audit results for Mn.

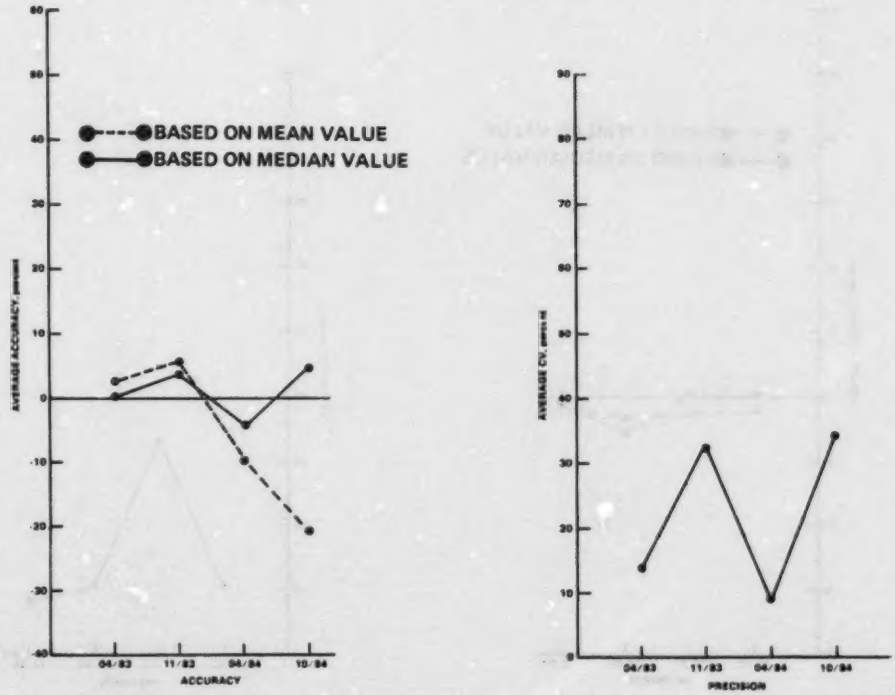


Figure 20. Acid rain audit results for Fe.

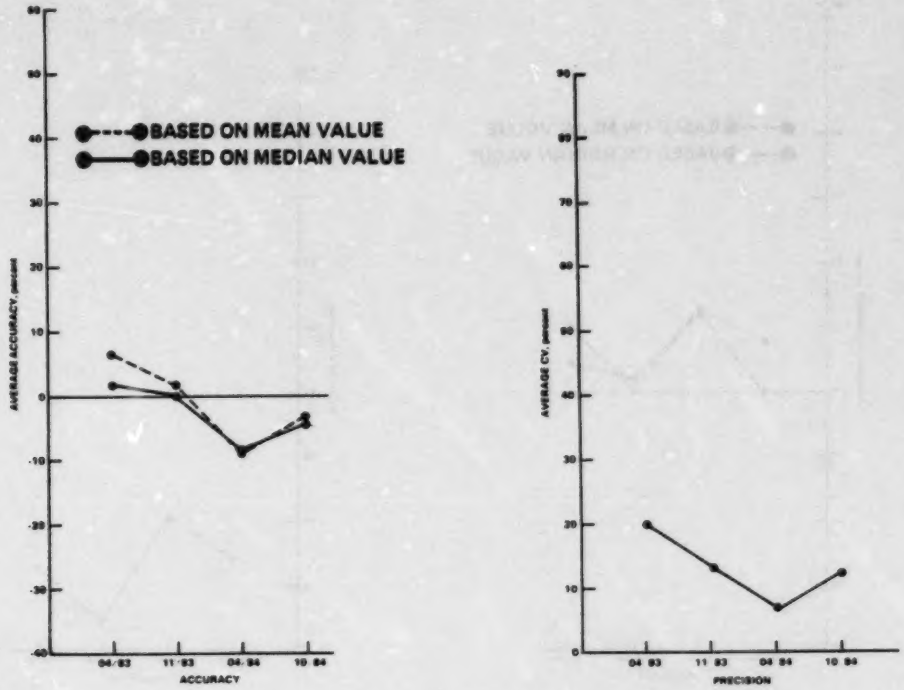


Figure 21. Acid rain audit results for Cd.

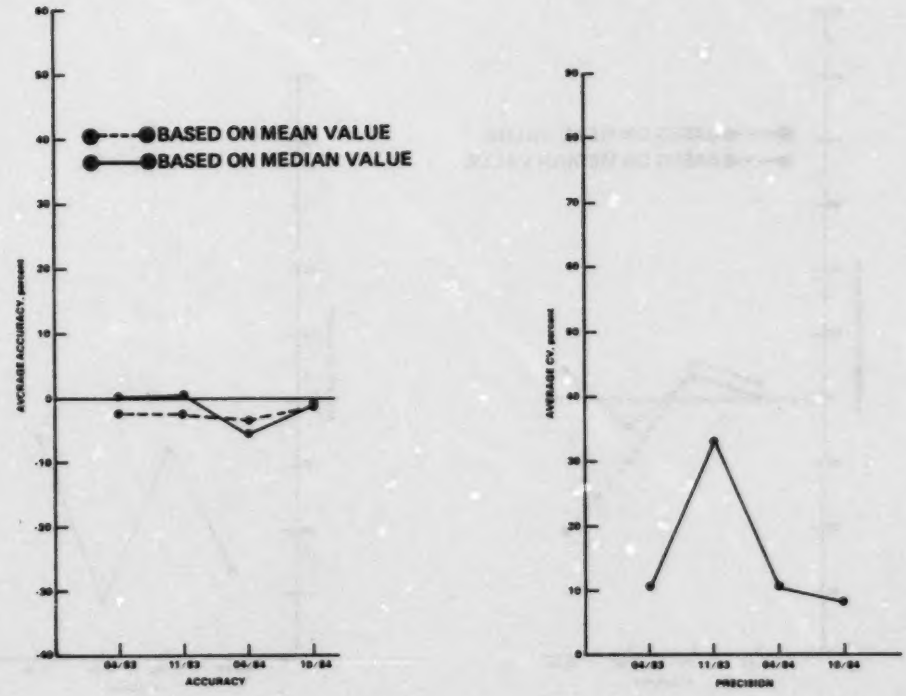


Figure 22. Acid rain audit results for Ca.

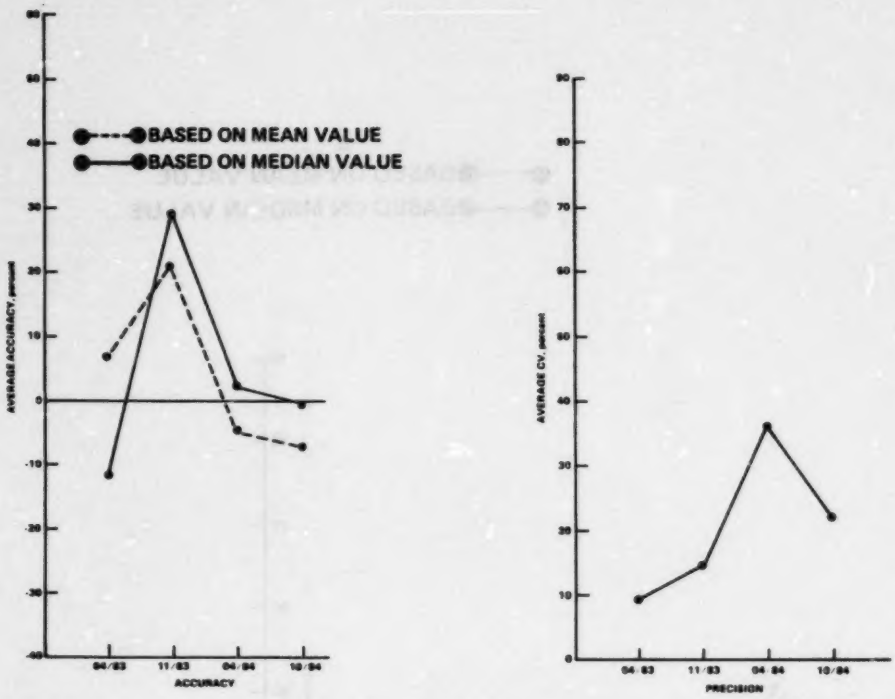


Figure 23. Acid rain audit results for Ni.

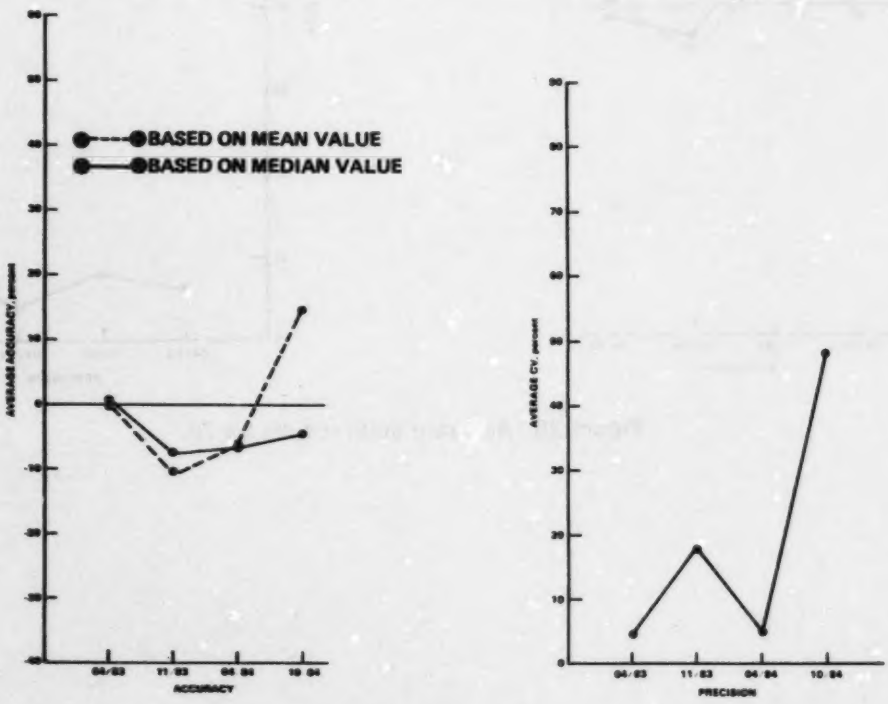


Figure 24. Acid rain audit results for Pb.

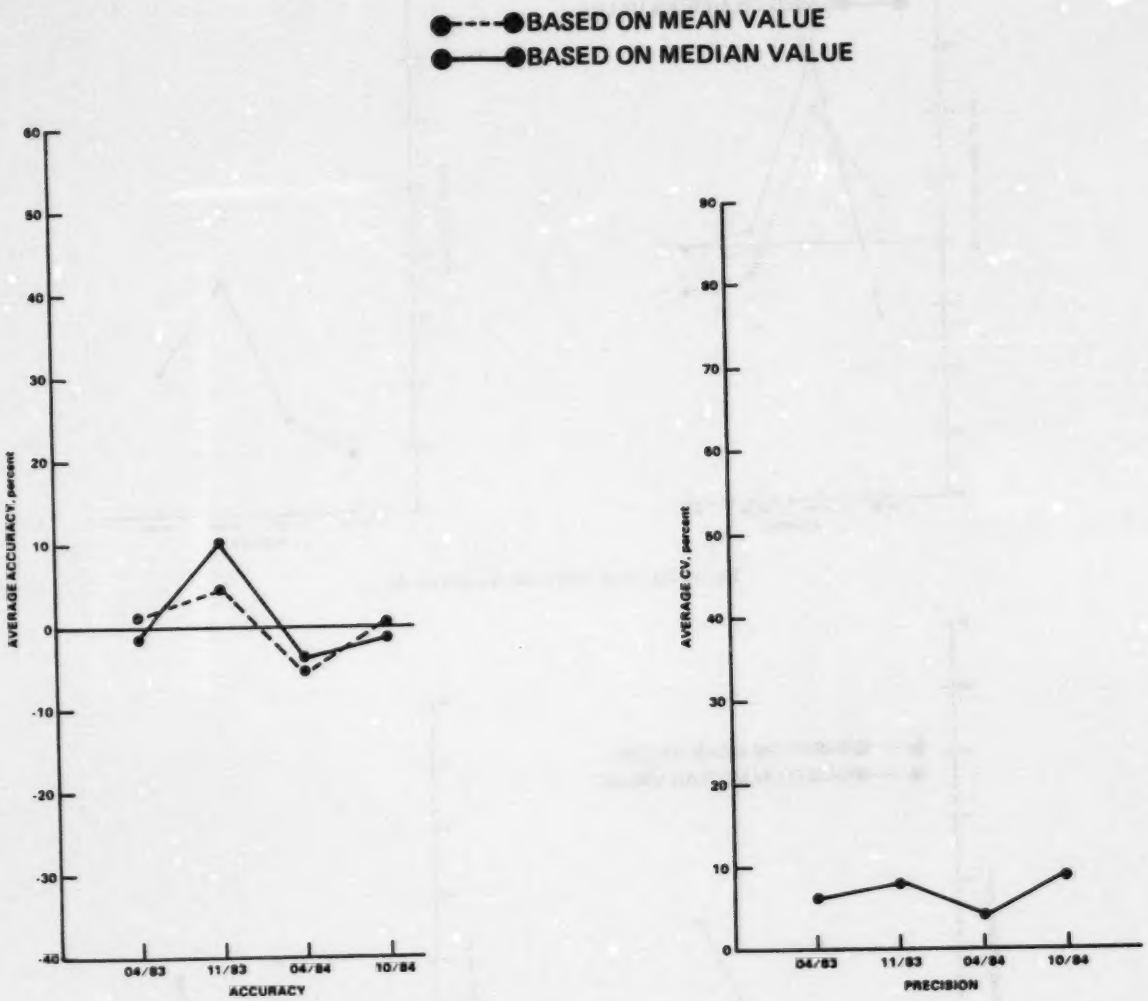


Figure 25. Acid rain audit results for Zn.

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